MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION, Amherst

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Annual Report

For the Fiscal Year Ending November 30, 1932

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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*In Charge +At East Wareham ‡At Waltham §On Leave **With U.S.D.A.

CONTENTS

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION — 1932

INTRODUCTION

F. J. Sievers, Director

The year 1932 marks the fiftieth anniversary of the Massachusetts Agricultural Experiment Station which was provided for by legislative act and founded in 1882. In common with similar institutions established at about the same date in several other states, the Massachusetts Station has a history covering a half century of service to the American people. The influence of this service on the control of insect pests, the prevention and cure of plant and animal diseases, the better utilization of farm products, the more scientific management of soil, the more systematic and economic feeding and handling of plants and animals, and in general the better management of the entire farm has had a profound expression in the inauguration of greater efficiency in agriculture and therefore, indirectly, in all industry. Increased efficiency as a rule results in the establishment of a so-called higher standard of living and a consequent demand for products and services beyond those required for a bare existence. In agriculture it has resulted, also, in a decrease in the labor necessary to maintain the same volume of production, thus affording an opportunity for the employment of this released labor in other industries and thereby providing for the many so-called luxuries of which the automobile, radio, good roads, better housing and heating facilities, and more liberal provision for education are good examples. For the enjoyment of luxuries a certain amount of leisure is required, and fortunately for the American public, the demand for luxuries and the leisure and income necessary to enjoy them kept fairly uniform pace. Industry boomed, jobs were plentiful, confidence was abundant, and credit unexcelled. Recently, however, when these major factors, which require equilibrium for our successful operation, became unbalanced or disproportionate we experienced an upset in our entire social and economic structure, with the result that at present many of us find ourselves either with more leisure than we can afford, or with more luxuries than our income can support. This fundamental weakness in our social and economic relationships can be permanently corrected only by recognizing the basic causes and dealing with them boldly and without fear or prejudice. This country is adequately supplied, yes, if not oversupplied, with all of the essentials of life. There is no universal lack of food, clothing, shelter, and, last but not least, of human energy ready and willing to apply itself. It is quite generally agreed that we suffer as individuals because of inadequate distribution of an abundant supply of these essentials. Food is not available where hunger exists. Clothing and good shelter are not accessible to those suffering from exposure. But most fundamental of all is the lack of proper distribution of labor or of the opportunity for all willing workers to make a living. To right this condition requires not only courageous research, but a program free from bias.

Of all agencies organized for public service there is none which should be better equipped as regards experienced personnel than the agricultural experiment stations. These institutions, because of their habit and experience in approaching without partiality problems requiring research, and also because of their record

of achievement in fields to which their energies have been directed in the past, should qualify to give aid in the development of a solution for our present problems of depression. There are already evidences that a constructive program based on research is desired. It is not unreasonable to assume that the general public is ready to place the same confidence in results gained by experiment stations in this field that the farmer has, in discoveries in the field of Agriculture. It is a project worthy of our foremost consideration.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Alexander E. Cance in Charge

Factors Affecting the Price of Eggs. (A. H. Lindsey.) Revised correlation analysis shows that the price level is the most important factor affecting the annual average price of eggs. For nearby eggs the annual average price decreases 5.68 cents for each 10-point decline in Snyder's index of price level. An increase of 100,000 cases in Boston receipts lowers prices 1.5 cents. For western eggs in the Boston market a 10-point decline in price level lowers the price 4.95 cents, and an increase of 100,000 cases in receipts lowers the price for this grade 1.4 cents.

Further refinement of the influence of various factors at different periods of the year is being carried on covering 12 years of data instead of the original shorter period of 6 years.

Forecasting devices worked out for estimating April average prices from January 1 and for estimating November average prices from June 1 have been found to predict future prices quite accurately.

Work similar to the study of egg prices has been started on factors affecting prices of live and dressed poultry.

Competitive Factors Influencing the Supply of Market Milk and Cream. (A. H. Lindsey.) A survey was completed of milk supplies in all important secondary markets outside of the Boston Metropolitan area. Information was obtained as to percentage of Massachusetts supply, consumption of grade A and pasteurized milk, price conditions, and policies in closed and open markets.

Some time was spent in gathering data from several milk distributors in or near Worcester. For the five distributors visited, preliminary figures on daily milk consumption for the month of April are as follows:

1928		1930		1932	
Number of Families	Quarts	Number of Families	Quarts	Number of Families	Quarts
229	350	322	506	377	548
1,494	1,939	1,822	2,380	1,569	2,133
.....	.....	994	1,367	1,245	1,714
2,003	2,768	2,153	2,821	2,134	2,906
1,284	1,790	1,841	2,563	2,468	3,312
5,010	6,847	7,132	9,637	7,793	10,613
Average per family per day	1.37		1.35		1.36

Shipping Massachusetts Apples. (A. H. Lindsey and A. A. Brown.) This investigation was initiated with the realization that the production of apples in Massachusetts is increasing at such a rate that within a few years Massachusetts

growers must depend on other than local markets. It was desired that the study should bring out the best methods of putting the apples on the more distant markets. The largest apple shippers in the State were visited in the survey. The experiences of these men in shipping apples were studied in detail; such as the comparative advantage of rail and truck shipments, packaging, grading, and methods of contract with motor carriers. Case studies were made of freight bills and of many cases in which legitimate and illegitimate charges were made against the grower or shipper. The reports show that considerable saving could be made by proper routing, and a knowledge of freight tariffs and tariff rules. It is intended to carry on further investigation of the markets next fall.

Recreational and Forestry Uses of Land. (David Rozman.) This project has been completed and the manuscript presented for publication. It points out the place of recreational and forestry uses of land in working out a balanced program of land utilization for the Commonwealth. The investigation indicates that, largely as a result of the abandonment of farm land, about one-third of the total area in towns with a population of less than 10,000 is owned by non-residents. In the towns situated near the coast and in some inland towns the land owned by non-residents is utilized to a great extent for recreational purposes. However, most of the abandoned farm land held by non-residents is represented by idle acres covered with brush and inferior woods. Although the indications are that a considerable amount of the present area of idle land will be taken in the near future for part-time farming and recreational uses, the major part of it will have to be devoted to the growing of trees under the control of both public institutions and private owners.

Marketing of Milk Secondary in Markets of Massachusetts. (David Rozman.) This study, initiated in the spring of 1932, deals with the analysis of marketing problems arising largely from changing conditions of milk supply in secondary markets of Massachusetts. The field work was carried on last summer in three cities situated outside of the Metropolitan area of Boston: Gardner in Worcester County, Attleboro in Bristol County, and Newburyport in Essex County. The data obtained in these cities include information on sources of milk supply and condition of marketing machinery, covering the practices and price plans of producers, distributors, dealers, cooperative organizations, and other distributing agencies.

Consumer Demand for Eggs. (Lorian P. Jefferson.) This project is nearing completion. Much of the tabulation is done, and a considerable portion is in manuscript form.

Changing Methods of Wholesale Distribution of Perishables. (Lorian P. Jefferson.) This project becomes increasingly more timely as distributors continue to seek better and less costly methods of marketing perishables and as new distributing agencies enter the field. It is evident that a process of decentralization is taking place in many places and in particular products. The warehousing of chain-store products is becoming a matter of districts, rather than states or larger regions. The Atlantic and Pacific chain, for example, now maintains several more warehouses in New England than formerly. The wholesale distribution of meat in Boston shows this tendency to decentralization, there being now several points at which meats are received and distributed.

Changes include certain new methods of handling credit and different methods of payment for goods. The growing importance of the traveling jobber, trucker, itinerant jobber, peddler — all these names being applied to the same agent —

is one of the outstanding features of the changes taking place in distribution. This is characteristic of no particular section of the country, and many are the efforts on the part of wholesalers and regular jobbers to control or eliminate this competition with their business. New England wholesalers seem not to suffer greatly from one aspect of this method that is found in other sections, where the traveling jobber buys directly from the grower and sells the product in the market where it would otherwise have been handled by the regular trade.

These aspects of the problem have received some attention, but all must have further investigation.

Analysis of Market Prices for Massachusetts Vegetables. (H. B. Rowe.) This project, begun in 1930, includes the analysis of annual and weekly variations in prices for eight leading vegetables on the Boston market: asparagus, cabbage, carrots, celery, cucumbers, spinach, squash, and tomatoes. Daily price and supply data have been tabulated for the ten-year period 1922–1931. From these data annual and weekly series have been compiled. Conventional methods of price analysis have been used in isolating and measuring the most important relationships explaining price variations. The study has now been practically completed through these stages for each vegetable except cabbage and cucumbers, on which some further analysis is required. A beginning also has been made in preparing the results for publication.

Results include the determination of fairly reliable relationships between prices, supply, and seasonal variation in demand for asparagus, bunched and cut carrots, Pascal and white celery, spring spinach, squash, winter and summer greenhouse tomatoes, and field tomatoes. For each of these products the analysis has furnished a very good explanation of the principal price variations which have occurred during the period included in the study. Also it has been possible to measure the relative importance of receipts from local farms and carlot arrivals as price determinants. In general, local supplies and trend have been the most important factors influencing year to year variations in prices for these products during the period since 1922. Likewise, supplies from local sources and normal seasonal changes account for the major price variations within the season. These relationships appear to have remained practically unchanged throughout the period. In the case of summer and fall spinach, results have been mostly negative in character, apparently due to the wide range of quality covered by available quotations. Results obtained from the project thus far contribute materially to an understanding of the market situation for the vegetable-producing industry of Massachusetts, since they provide definite information regarding price movements and their causes. Such knowledge permits a more reliable interpretation of current market developments by producers as a basis for production and marketing plans. Furthermore it gives a more dependable basis for outlook work and shows the more important items which should be covered in current market reports.

DEPARTMENT OF AGRICULTURAL ENGINEERING

C. I. Gunness in Charge

Investigation of Apple Storages. (C. I. Gunness.) A study of the effect of humidity on evaporation from apples in storage at various temperatures was started in the fall of 1931. Based on the first year's operation, it is apparent that humidities of 70 and 75 per cent cause considerably more evaporation than a humidity of 88 per cent at all temperatures. It was found, however, that the

difference in rate of evaporation at various humidities was greater at high temperatures. The study is being continued during the present season in an attempt to narrow the range of humidities used and determine the lowest humidity which can be safely used without causing shriveling.

Fertilizer Distributors. (C. I. Gunness). A fertilizer attachment was developed for a tobacco transplanter, which would apply the relatively large amount of fertilizer used in the Connecticut Valley and place the fertilizer in bands on both sides of the row of plants. Tobacco was planted with fertilizer applied at different depths and different distances from the row in a test carried out and reported by the Department of Agronomy.

Test of Low-Lift Pumps. (C. I. Gunness.) Additional pumps were tested at the Cranberry Station during the past season. The result of the tests made during the past three years will be published at an early date.

DEPARTMENT OF AGRONOMY

A. B. Beaumont in Charge

Pasture Experiments. (A. B. Beaumont and E. F. Gaskill.) Experiments in the improvement of upland pastures by top-dressing with fertilizers have been continued. The results of 1932 are in general accord with those reported in recent years and summarized in Bulletin 282 published recently.

Work is in progress on the question of form of nitrogen best suited to our pasture conditions. Indications to date are that nitrates, ammonium salts, urea, and calcium cyanamid can each be used advantageously under certain conditions. Experiments with cyanamid have shown that when it is applied in amounts above 200 pounds per acre, a more or less transitory "burn" of grasses and clovers occurs, regardless of the season of the year when applied; but this effect is not considered a sufficient reason for not using this material.

Legume Variety Tests. (J. L. Haddock, A. B. Beaumont and M. C. Darnell, in cooperation with Division Forage Crops and Diseases, Bureau of Plant Industry, U.S.D.A.)

Alfalfa. The highest-yielding varieties for 1932 were as follows:

1929 seeding: Hardigan (4.91 tons), Kansas, Arizona, Utah, and Ontario.

1930 seeding: New Mexico (4.75 tons), South African, California, Argentine, and Oklahoma.

1931 seeding: Hardigan (4.63 tons), Argentine (4.63 tons), New Mexico (19010), New Mexico (19011), and Grimm.

Red Clover. Nineteen strains of red clover were seeded in 1931, and two cuttings were harvested in 1932. The results were similar to those reported last year; namely, that the northern-grown American strains outyielded the European. Tennessee (19002) gave the highest yield (3.10 tons).

Vetch. In the test seeded in the fall of 1931 with rye as a companion crop, the highest yield of vetch alone was from Smooth (0.702 tons), followed in order by Oregon Hairy, Common Hairy, Hungarian, and Oregon Common. In the 1932 spring seeding with oats, the best yield of vetch alone was from Smooth (1.07 tons), followed by Oregon Pearl, Common Hairy, Hungarian, and Oregon Common.

Field Peas. Peas were seeded with oats as a companion crop in 1932. Golden Vine gave the best yield (0.807 tons) of peas alone, followed in order by Chang, O.A.C. 181, Multiplier, Common, and Austrian Winter.

Soy Beans. In the test of 1932, several of the varieties which gave low yields in previous years were discarded as being unsuitable for forage under conditions here. Some new varieties were included in the test. The highest-yielding 10 varieties were: Mukden (new 1932) (2.59 tons hay), Wea, F.P.I. 50536 (new 1932), F.P.I. 63242-2 (new 1932), Dunfield, Harbinsoy, Manchu, F. C. 03654-A, Mansoy, F.P.I. 53933-3B (2.33 tons). Rows were 36 inches apart in 1932, 30 inches in previous years.

Field Experiments with Onions. (M. E. Snell and A. B. Beaumont.)

Fertilizer ratios. The field experiments with lime and fertilizer ratios were continued with no radical changes. This completes three years' records with onion sets, which have proved better adapted to the work than seed onions. The past season, the 4-12-8 (organic) and the 4-12-4 ratios (these figures refer to percentage of NH_3, P_2O_5, and K_2O) were the only ones which yielded higher than their 4-8-4 check plots. The 6-8-8, 4-8-8, 4-12-8 (inorganic), and the 2-12-8 ratios were again poorer than their check plots.

Over the three-year period the 4-12-4, 4-12-8 (organic), and the 4-8-4 (with 2-0-0 nitrate top-dressing) gave slightly higher yields than their 4-8-4 check plots. The 6-8-8, 2-12-8, 4-8-8, and 4-12-8 (inorganic) were all inferior to their check plots. The 6-8-4, 8-16-8, and 4-7-4 (with 2-1-0 fish top-dressing) were about equal to their check plots. Application of lime, in excess of three tons, gave an increase in yield of 5 to 10 per cent for the three-year period. When the lime was withheld and the phosphorus doubled with a 4-8-4 and a 4-12-4, the yield was increased about 10 per cent. When 600 pounds per acre or 1200 pounds per acre of superphosphate were supplied in addition to the 4-8-4, and lime was applied annually for five years at the rate of 1000 pounds per acre instead of in three 1-ton applications over a period of seven years, the increase was 21 and 27 per cent respectively. However, the same applications of superphosphate applied with 500 pounds of lime annually, gave but slight increase over the three 1-ton applications without the extra superphosphate.

Onion set experiment. Last year some preliminary work was done in an attempt to determine methods of getting maximum yields of a desired size of set for planting. Also, the effect of the conditions under which they were grown on the keeping quality of the sets was studied. In these tests 50 pounds of seed per acre, 500 pounds per acre of a 4-12-8 fertilizer, and seed distributed over a two-inch-wide row proved the most satisfactory of the rates tried. The most desirable size of set, 1/2 to 3/4 inch, showed least loss in storage from sprouting, decay, and moisture loss. This size sprouted less than the largest size and decayed less than the smallest two sizes. The lighter seedings and the wider rows showed less loss than the heavier seedings and narrower rows. There was little decay where 500 pounds per acre of a 4-12-8 fertilizer were used.

During the past season more extensive work was done. Four fertilizer levels were used; namely, 500 pounds per acre of a 0-12-8, 2-12-8, and 4-12-8, and 1000 pounds of a 4-12-8. The rates of seeding were 30, 40, and 50 pounds per acre, and the seed was distributed over one-, two-, and three-inch-wide rows with the 500 pounds per acre of the 4-12-8 fertilizer; but two-inch rows were used on all other fertilizer treatments. It was again clearly shown that there is a balance between the food supply and the population, which must be maintained in order to produce maximum yields having a high percentage of a desired size. Forty pounds of seed per acre were adequate with 500 pounds of the 2-12-8, but 50 pounds were needed with 500 pounds of the 4-12-8; 1000 pounds per acre of the 4-12-8, even with a high rate of seeding, supplied too much plant food for a good crop of sets. Five hun-

dred pounds of the 0-12-8 did not give a high yield of either total sets or sets of the desired size; but gave a very high percentage of sets of the desired size, especially with 30 and 40 pounds of seed per acre. In general, 30 pounds of seed per acre were not enough for best results, and the three-inch rows seemed to give better opportunity for development than the narrower rows. Several of the plots yielded over 12,000 pounds per acre of sets of the 1/2- to 3/4-inch size.

Onion Breeding. (M. E. Snell.) This project was continued during the past summer as previously, except for one change in technique. Previously two types of inbreeding had been used. In one, designated as "mass fertilized," all bulbs of each selection were planted close together and just before flowering were surrounded by a netting-covered frame which permitted fertilization among bulbs of the same strain. In the other, known as "self fertilized," each flower head was given a separate covering. Since the two methods seemed to give very similar results, and the former was the more expensive, it has been discontinued.

The seed from the inbred strains, which were crossed a year ago was planted, and a few more cross-matings were made this year. A good crop of bulbs was produced and is being housed in the new storage which was recently completed. This storage should greatly facilitate the work by permitting bulbs to be carried over for breeding purposes, which was not possible with the former facilities.

Field Experiments with Tobacco. (A. B. Beaumont and M. E. Snell.)

Cropping systems. Results of eight years (1924-1931) of experiments on the effect of cropping systems on the yield and quality of tobacco have been summarized for publication in bulletin form. Cover crops were in general beneficial. Of those studied, red top (*Agrostis alba*) was the most, and timothy (*Phleum pratense*) the least beneficial. The highest yield was produced where tobacco was grown continuously with fertilizer and a cover crop of red top, but the best quality of tobacco was produced where manure was used as a supplement to the fertilizer. Tobacco grown in rotation with other crops was low in yield and poor in quality.

In the season of 1932 some changes were made in the cropping systems, including the substitution of oats for rye as a cover crop. The concentration of the nitrogen in the fertilizer used was raised from 4.1 per cent (used 1924-1931) to 5.0 per cent. Red top cover again produced the highest yield (1907 pounds) of all cover crops used, but was slightly surpassed by the manure supplement with no cover. In comparison with no-cover (check) plots, oats, timothy, and rye cover crops depressed the yield in the order given. The yield from the rotation plots was of the same low order as in previous years. The addition of sodium nitrate and calcium nitrate to certain rows of tobacco in the rotation plots did not increase yield but did raise the nitrate content of the soil to a high point. The addition of dried peat in a similar way increased the yield of tobacco.

Form of nitrogen. The old experiment on single forms of nitrogen was modified in 1932. One half the fertilizer nitrogen was supplied from cottonseed meal and the other half from each of the following carriers: sodium nitrate, ammonium sulfate, urea, and calcium cyanamid. The standard fertilizer mixture containing nitrogen from cottonseed meal, sodium nitrate, and calurea was used as a check. In case of tobacco following tobacco, calcium cyanamid and the standard mixture produced the highest yields, followed closely by ammonium sulfate, urea, and sodium nitrate; but after timothy cover or sod, the order was standard mixture (highest), ammonium sulfate, urea, sodium nitrate, and calcium cyanamid.

A new experiment on different proportions of organic and inorganic nitrogen

for tobacco was started in 1932. The organic nitrogen was supplied by cottonseed meal, and the inorganic nitrogen by a mixture of equal parts of sodium nitrate and ammonium sulfate. The fractions of organic nitrogen were 1/8, 2/8, 3/8 and 4/8 of the whole. Comparison was made with the standard mixture. The highest yield (1954 pounds) was obtained with 1/8 organic nitrogen and 7/8 inorganic, followed by 4/8, 3/8 and 2/8 organic. All mixtures yielded more than the standard mixture. Since organic nitrogen is generally assumed to have an especially favorable influence on quality of tobacco, it will be necessary to await the sorting records for these treatments before they can be properly evaluated.

The experiment on different total amounts of nitrogen was discontinued in 1932.

Method of applying fertilizer. Prof. C. I. Gunness of the Agricultural Engineering Department modified the transplanting machine used in these experiments so that fertilizer could be placed by the machine at the time of setting tobacco. The fertilizer was placed in bands 3 inches wide at each side of the plant and 1 inch from it. The standard broadcast application of 3500 pounds per acre was compared with machine application of 4/8, 5/8 and 6/8 of the standard amount of fertilizer. The average yields of tobacco (pounds per acre) were as follows:

Machine Application		Broadcast (Check)	
4/8 Standard application	1846	Standard application	1822
5/8 Standard application	1732	Standard application	1855
6/8 Standard application	1861	Standard application	1881

Comparable experiments were conducted on several private farms of the vicinity. Results obtained thus far from these experiments are similar to those obtained on the station plots. On account of the possible residual effect of fertilizers used in previous years, it will be necessary to continue this experiment several years on the same field.

Distribution of Nitrogen in the Tobacco Plant. (W. S. Eisenmenger.) Tobacco plants were grown in nutrient solutions for about one month. They were then divided into four groups of fifty plants each. Two groups received the same complete nutrient solution — one growing in normal light, the other growing in complete darkness. From the other two groups nitrogen was withheld — one in the light, the other in darkness. The plants were continued thus for eleven days. At the end of this period all were harvested and divided into roots, stems, mid vein and residual leaf portion. They were kept frozen until they were analyzed for total and water soluble nitrogen, a - amino acids, ammonia, amides, protein, peptid, humin, and nitrate nitrogen. The results indicated that much of the nitrate is reduced in the aerial portion of the plant, at or near the mid vein. Darkness increased the nitrate and a-amino acid in the plants and decreased the leaf weight. Withholding nitrogen lowered the dry weight of roots and stem.

The results of this investigation have been accepted for publication in the *Journal of Agricultural Research.*

Toxicity of Aluminum for Tobacco. (W. S. Eisenmenger.) Tobacco plants were grown in nutrient solutions for slightly less than two months. The solutions were renewed every second day. For two days they grew in a complete nutrient solution (Knop's), and on the succeeding two days the solution was the same except that phosphates were withheld and aluminum citrate was added in varying concentrations — 0, 2, 5, 15, 30, 50, 70, 85, 95, 98, and 100 per cent of .006 Mol. Definite toxicity effects were indicated in the dry weights of top and roots.

Similar toxicity effects are being determined for the seedling stage of soy beans,

corn and buckwheat in single-salt solutions. Also the ameliorating effects of Ca, K, OH and Mg ions in separate cultures are noted.

Magnesium Requirement of Crops. (A. B. Beaumont and M. E. Snell.) The crops grown in the field in 1932 were alsike clover, buckwheat, soy beans, corn, and oats. Oats on magnesium-deficient plots exhibited a marked chlorosis of intervenous leaf tissue in the early stages of growth, but lost this sympton in later stages. Buckwheat and corn developed mottled chlorotic leaves in the late-growth stages. Only in case of buckwheat was the yield better on plots which received magesium sulfate than on magnesium-deficient plots.

Top-dressing Grasslands with Fertilizers. (A. B. Beaumont and M. E. Snell.)

Fertilizer ratios. This experiment was expanded in 1932 to include a wider range of ratios. In both the old and the new portions of the experiment the results show a definite response to increments of potash only. The highest yield was from fertilizer having a ratio of 3:3:8 ($N:P_2O_5:K_2O$). High nitrogen failed to rank as high as in the past four years, probably because a second cutting could not be made on account of the drought of the latter part of the summer.

Forms of nitrogen. In a new experiment in the top-dressing of an old mowing (meadow) with different commercial forms of nitrogen, the highest yield was obtained from nitrate of soda, followed by ammonium sulfate, urea, and calcium cyanamid in order. Here, again, on account of dry weather no second cutting was available, and this may have affected the order of the results.

Assimilation of Fixed Nitrogen by Grasses and Clovers. (A. B. Beaumont, W. S. Eisenmenger and W. J. Moore.) Five species of grasses and clovers used for forage were grown in sterilized and unsterilized solution cultures which contained sodium nitrate, ammonium sulfate, or urea in addition to the requisite minerals. From the weight of dry matter produced and from the chemical composition, it was concluded that nitrogen was assimilated most completely in the form of nitrate by the grasses, and in the form of urea by the clovers. In the later stages of growth, ammonium sulfate and urea became toxic to both grasses and clover. In the unsterilized cultures the roots became dark and decayed, but in the sterilized cultures they remained white and sound. In explanation of the darkening and decay of the roots, the narrowing of the C-N ratio by the accumulation of unassimilated nitrogen in the roots is suggested. The addition of calcium carbonate to the ammonium sulfate solution maintained the reaction near the neutral point, but this did not prevent the injurious action on the roots, nor did it materially increase the growth of the plant and the assimilation of nitrogen.

Nitrification of Castor Pomace, Soy Bean Meal, and Other Organic Materials. (M. H. Cubbon.) Nitrate nitrogen accumulation in an acid soil of low fertility as influenced by the above materials was studied in the laboratory over a three-month period. Readings were taken at 10-day intervals. The nitrogen content of the castor pomace samples varied from 4.36 to 5.80 per cent. In three months' time 75 to 100 per cent of the nitrogen in castor pomace and soy bean meal was nitrified. High oil content (10.24 per cent in castor pomace and 18.62 per cent in soy bean meal) slightly hindered but did not prevent nitrate accumulation. Nearly half the nitrogen in such organic materials as peanut shell meal, garbage tankage, ground peat, "soil sponge," and "hyper humus" changed to nitrate in three months. Peanut shell meal caused a decided depression of nitrates for the first month. Nitrate accumulation from sulfate of ammonia proceeded at average level after the first month. Apparently a month is necessary in this soil for nitrate accumulation to be noticeable.

Effect of Varying Amounts of Moisture and Organic Materials on Soil Nitrates. (M. H. Cubbon.) Nitrate nitrogen was produced in large quantities in potted soils which had been treated with different (and large) amounts of domestic peat and manure. The moisture content was purposely varied in different pots. Nitrates increased with increase of moisture up to about 35 per cent. Nitrate nitrogen disappeared from the soil, or was greatly reduced, when turnips began to grow vigorously. Soils which received excessive amounts of manure (80 tons), or peat equivalent to 20 tons of manure, maintained a relatively high nitrate nitrogen content throughout the growing season. (This is part of a study of factors affecting "dark center" of turnips, in cooperation with the Department of Olericulture.)

Fine Turf Grasses. (L. S. Dickinson.) Further studies have been made regarding the desirability of pre-seeding fertilization of newly built or newly seeded turf areas, and a check experiment has been conducted to verify the results obtained in 1931. Nitrogen, phosphorus, and potash were applied singly and in combinations prior to seeding with Kentucky bluegrass and Colonial bent. The check experiments were conducted in deep boxes, placed out of doors and unprotected. The results obtained again indicate that on normal soils pre-seeding fertilization with anything but superphosphate or a single phosphorus carrier is unnecessary. Also, that stronger young plants are obtained without pre-seeding nitrogen and potash, and that the plants will more economically use fertilizer applied as a top-dressing when they are from 60 to 70 days old. This project was made possible by the New England Greenkeepers' Association.

The plots maintained in cooperation with the United States Golf Association, and the nine-year-old lawn plots on one of the regular campus lawn areas, are the only plots that are now being maintained, due to the decrease in funds.

A new project, made possible by Brague Inc., has been started to determine the advisable amounts of peat to be mixed with various types of soil to improve the physical condition. This involves a study of methods of determining, easily and quickly, yet with practical reliability, the physical strength of soil samples. A study is being made, also, of methods of establishing definite soil standards to use in comparative work.

DEPARTMENT OF BACTERIOLOGY
Leon A. Bradley in Charge

Nitrogen Fixation in the Presence of or as a Result of Legumes Versus Non-Legumes. (J. E. Fuller.) Additional studies have been made to determine the activity of nitrification and carbon-dioxide evolution, for the purpose of comparing these activities with nitrogen fixation in the same field in which previous studies have been made. Dried blood and ammonium sulfate respectively were added to the soil, and the rate of nitrification of these substances was determined. Carbon-dioxide evolution was determined from soil samples to which oat straw had been added. All of the experiments were carried out in pots in the laboratory. The soil samples studied represented two lots, one lot having been collected before the field was plowed in the spring, and the other in the fall after the crops had been harvested. No influence was observed, on the part of the legume crop as compared with the non-legume crop, on nitrification or cellulose decomposition. A paper describing the study in detail has been accepted for publication in *Soil Science*.

Influence of Temperature on the Nitrate Content of Soil in the Presence of Decomposing Cellulose. (J. E. Fuller and L. H. Jones.) This study was

carried out in cooperation with the Department of Botany. The results of the experiments have been published (*Soil Science* 34:337-351, 1932), and reference may be made to the published paper for details of the study.

Application of the Soil Plaque Method for Determining Mineral Deficiencies in Massachusetts Soils. (J. E. Fuller.) The method depends on the growth of Azotobacter as an indicator of the presence in the soil of minerals essential to the growth of crops. The results obtained from the soils studied indicated that the method cannot be depended upon for determining the deficiency of available phosphorus under the conditions existing in the field from which the samples were taken. It was observed that the soils did not contain sufficient phosphorus to support Azotobacter growth, even though the field from which the samples were taken had produced satisfactory crops. Further studies are being made with soil samples collected from more widely distributed areas.

Bacteriological Studies of Dried Milk Powders. (J. E. Fuller and R. L. France.) Several samples of dried milk powder were examined for the presence of the tubercle bacillus in order to determine the safety of the powder for feeding calves. Some of the samples were from milk powder dried by the roller process; others, from milk powder dried by the spray process. The latter, being easily soluble in water, were made into solution and inoculated into guinea pigs. The animals of this group were observed for a month and then killed. The milk powder dried by the roller process was only partially soluble in water, so the powder was mixed with other food and fed to guinea pigs. The animals of this group were observed for two months and then killed. Both groups of guinea pigs appeared to be healthy throughout the periods of observation. The weights of all of the animals showed gradual increase. Autopsies did not show any evidence of tubercular infection in any of the animals. The experiments indicated that the milk powders studied did not contain tubercle bacilli. These results agreed with those obtained by other investigators.

Udder Infection in a Cow. (J. E. Fuller and R. L. France.) The udder infection studied occurred in a cow of the experiment station herd. An organism was isolated from the milk and also from the udder when the cow was killed. The blood serum of the cow agglutinated the organism to a titer of 1 to 1,280. The study will be reported more in detail at a later date.

Laboratory Service. (R. L. France.) Following is a list of the number and types of examinations made by the laboratory during the past year:

Milk (bacteria counts)	1,160
Water analysis	123
Miscellaneous:	
*Butter fat	197
*Milk solids	7
Baby foods	12
Throat swabs	10
Chlorine	4
Yeast	2
Powdered milk	1
Anaerobes	1
Food poisoning	1
TOTAL	1,518

*Analysis made by P. H. Smith, Feed Control Laboratory.

This is an increase of 270 examinations over the previous year, due mostly to bacterial and chemical examinations of milk. This phase of the service has increased yearly, and the laboratory is providing a valuable service to milk producers, dairymen and local health inspectors throughout the Valley.

The number of water analyses has shown a decrease during the past year. This is probably due to the fact that the laboratory is unable to make a sanitary survey of the supplies examined. Without this survey it is impossible to offer constructive suggestions in the care of polluted supplies.

The stock of legume cultures has been kept intact and these were furnished to farmers requesting them for inoculation of leguminous plants.

Upon request of the Horticultural Manufactures Department bacterial examination of samples of a new baby food were made.

Bacterial counts of milk samples held under different cooling methods were made for the Dairy Department.

The Indol Tolerance of the Colon-Aerogenes Group of Bacteria as a Possible Means of Differentiating Fecal and Non-Fecal Strains Occurring in Drinking-Water Supplies. (R. L. France.) Preliminary work on this project has been completed and accepted for publication in the *Journal of Bacteriology* under the title, "Bacterium coli in rural privately owned water supplies."

The results obtained in this investigation suggest that dependence on the Standard Methods procedure alone for determining the sanitary quality of drinking water, especially from privately owned supplies of unknown history, results in too many of the samples being condemned. The need of supplementary differential tests is indicated, but results do not justify the recommendation of any particular test or group of tests.

In an effort to derive a satisfactory test, work is being done to determine the indol tolerance of strains of the Colon-aerogenes group of bacteria. Results to date do not justify any statement regarding sharp differences among strains.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Black Root-Rot of Tobacco. (W. L. Doran.) Tobacco was grown for the tenth successive year in plots last limed in 1923. In 1932, there was no black root-rot in plots not limed, the soil of which has a pH value of 5.2, but the disease was moderately severe in adjacent limed plots, the soil of which has a pH value of 5.9. The average yields of tobacco per acre in 1932 were 1906 pounds in plots not limed and 1559 pounds, or 18 per cent less, in plots limed. The persistence of the effects of lime on black root-rot and yields of tobacco is indicated by the fact that, with lime last applied in 1923, loss in yield in limed plots (as compared with yield in plots not limed) has been as follows: 10 per cent in 1924, 45 per cent in 1925, 43 per cent in 1926, 35 per cent in 1927, 23 per cent in 1929, 25 per cent in 1930, 16 per cent in 1931, and 18 per cent in 1932. The sorting record of the crop of 1931 (the latest crop sorted) showed that lime applied in 1923 was still resulting in impaired quality as well as reduced yields. The fire-holding capacity of the crop of 1931 was not injured by lime, however.

In pot experiments, infection of tobacco by *Thielavia basicola* (Berk. and Br.) Zopf was much reduced or, more often, entirely prevented by ammonium thiocyanate applied to soil at the rate of 900 pounds per acre. This rate of application was as effective in preventing infection as were heavier applications. It resulted, however, in soil toxic to tobacco for 18 weeks, although not for 25 weeks, after

treatment. The length of time toxicity persisted was not shortened by the supplementary use of ferric chloride.

Calcium cyanide applied to soil at rates up to 1800 pounds per acre did not prevent infection of tobacco by Thielavia. Heavier applications reduced the severity of infection without increasing soil acidity, but were toxic to plants.

Brown Root-Rot of Tobacco. (W. L. Doran.) When this disease developed following timothy in a cropping system, it was usually more severe in clay soils than in sandy soils. The addition of timothy to a soil was sometimes beneficial to tobacco, the benefit being greater in sandy soils than in clay soils. In general, timothy when followed by brown root-rot of tobacco was less harmful in sandy than in clay soils; and timothy when it did not result in brown root-rot of tobacco was followed by better growth of tobacco in sandy than in clay soils.

Disease Resistance of Potato Varieties. (W. L. Doran.) The varieties Green Mountain, Katahdin, and Foster's Rust-proof were compared. There was no late-blight and there was little or none of the virus diseases. The season was dry and there was much injury of Green Mountain and Katahdin by drought, tip burn, and insects (aphis and leafhopper). Under these conditions, Foster's Rust-proof was much more resistant and long-lived than either Green Mountain or Katahdin.

Downy Mildews of Cucumbers and Lettuce. (W. L. Doran.) Downy mildew of cucumbers (*Peronoplasmopara cubensis* (B. & C.) Clint.) was not observed here in 1931, but it appeared on August 18 in 1932. This is the latest recorded date of its first appearance here in any year. An account of investigations of this disease by the writer has been published recently in Bulletin 283.

It was found that resin has a markedly fungicidal effect on *P. cubensis*. A stock solution was made of resin 5 parts, wood alcohol 5 parts, and potassium hydroxide 1 part. This was then diluted with water so as to contain resin in the proportions indicated below. Infection of cucumber plants, sprayed with resin solutions previous to inoculating with *P. cubensis*, was entirely prevented by resin 1:150 and reduced to only a trace by resin 1:200. There was no injury to cucumber plants by resin 1:150, although they were slightly injured by resin 1:100.

Downy mildew of lettuce (*Bremia lactucae* E. Regel) was severe on the variety Bel-May in greenhouses in April 1932, although this variety had been previously considered relatively resistant.

The resistance of certain varieties of lettuce was shown by the average number of plants which became infected out of each 100 plants inoculated with *B. lactucae*. These were as follows: Dreer's Wonderful, 25; Sutton's Golden Ball, 24; Rosy Spring, 3; Dreer's Iceberg, 1; Loos Tennis Ball, 0; Loos Tennis Ball (Vilmorin's), 0.

Germination of the conidia of this fungus was prevented when the conidia, in water, were placed on micro-slides which had been sprayed with resin 1:100. A 0.25 per cent solution of sodium tetraborate (borax) similarly used was likewise effective in preventing germination. Anhydrous sodium carbonate was ineffective at the concentrations used.

With over 90 per cent of these conidia germinating in water, less than 10 per cent germinated in a 1 per cent water solution of the exudate from cut stems of lettuce plants.

Sporulation of *B. lactucae* was entirely prevented by dusting infected plants with sulfur dust. Copper-lime-arsenic dust was nearly as effective.

Eggplant Wilt. (E. F. Guba, Waltham.) Growth of Verticillium in culture occurred at a range of 50°-95° F., with the optimum at 78°. The best growth of

eggplant occurred at a soil temperature range of 77°-95° F., and most infection at 77°. No infection occurred at soil temperatures of 55.4° and 95° F.

When aluminum sulfate was used to acidify the soil, no infection occurred at pH values below 5.0; and when inoculated sulfur was used, there was slight infection at pH 4.0-4.2. Aluminum sulfate gave more consistent control of wilt at the low values than sulfur.

Results of field applications of aluminum sulfate and sulfur were disappointing and revealed no justification for artificial soil acidification in the field as a means of control. The culture of eggplant on naturally acid sod land offers the best means of controlling wilt. The investigation is concluded with this report.

Control of Greenhouse Vegetable Diseases. (E. F. Guba, Waltham.)

Tomato leaf-mold. Extensive tests reveal the lack of immunity among any varieties of tomatoes to attack by *Cladosporium fulvum* Cke., but some varieties show a mild resistance as expressed in slight spore production, belated infection, and yellow spots, in contrast to a rich growth of the fungus on foliage of susceptible varieties. The varieties Maincrop, Up-to-Date, Norduke, and Norton were most resistant. Maincrop and Up-to-Date produce small, smooth tomatoes and set heavily; Norduke and Norton produce large, rough tomatoes and set very poorly under glass. Reciprocal crosses of these varieties have been obtained for future study. Riverside X Up-to-Date, Stonnors M. P. X Up-to-Date, Maincrop X Up-to-Date, and E. S. 1 X Up-to-Date, crosses made by Dr. W. F. Bewley of England for resistance to Cladosporium, are similar to Maincrop and Up-to-Date in cropping characters and resistance. Of these four hybrids, Stonnors M. P. X Up-to-Date and Maincrop X Up-to-Date were most resistant. These hybrids have been crossed further with Norton and Norduke in the hope of developing a suitable greenhouse tomato which is, at least, less troubled by the disease than the standard varieties now being grown.

A paper dealing with the relation of environment to the development and control of tomato leaf-mold under glass is in preparation.

Effect of hydrocyanic acid gas on cucumber plants sprayed with copper fungicides. Cucumber plants were always injured when gas followed copper fungicides containing calcium hydroxide, sodium hydroxide, or sodium carbonate. Even when the alkali compound was reduced to produce neutral mixtures, injury resulted after gas. Injury occurred regardless of whether the gas was evolved from Cyanogas or from sodium cyanide, or whether chemical hydrated lime, milk of lime, or lime water was used in the preparation of Bordeaux.

Injury was always correlated with water soluble copper which increased with the amount of alkali present in the spray.

Residues of Bordeaux on glass acted upon by gas yielded soluble copper and hydrocyanic acid gas, and these occurred in a fairly constant ratio. The toxic salt is presumably calcium cuprocyanide $CaCu_2(CN)_45H_2O$.

If spraying greenhouse cucumbers with Bordeaux is warranted, fumigation with hydrocyanic acid gas should precede the copper treatment, or cyanide fumigation should be abandoned in favor of tobacco fumigants. The investigation is concluded with this report.

Control of the root-knot nematode in greenhouses with carbon disulfide emulsion. This investigation has been completed and the results published in Bulletin 292.

Eradication of Nematodes in Greenhouse Soils by the Use of Chemicals. (L. H. Jones.) In further experiments, using a mixture of liquid orthodichlorobenzene adsorbed in diatomaceous earth and calcium cyanide, nematodes were eradicated from soil in six-inch flower pots that was heavily inoculated with large

nematode galls from tomato roots. Orthodichlorobenzene adsorbed by diatomaceous earth and lacking calcium cyanide has little nemacidal value. Calcium cyanide alone will materially reduce the injury caused by nematodes, but the addition of orthodichlorobenzene prolongs the nemacidal activity of the cyanide and has effected eradication.

The most effective mixture from the standpoint of eradication without subsequent injury to seed germination and plant growth proved to be, by weight: 1 part orthodichlorobenzene (12.5 grams) adsorbed by 4 parts diatomaceous earth (50 grams) and then mixed with 2 parts calcium cyanide (Cyanogas) (25 grams). Two treatments of the soil are necessary with this mixture, with an intervening interval of a week, and a final interval of 10 days before seed is planted.

Acetic Acid and Pyroligneous Acid as Soil Disinfectants. (W. L. Doran.) It was found that either of these chemicals can be substituted for formaldehyde for soil disinfection to prevent damping-off, and at less cost than formaldehyde. A description of this work has been published in the *Journal of Agricultural Research* 44:571-578, April 1, 1932, under the title, "Acetic acid and pyroligneous acid in comparison with formaldehyde as soil disinfectants." Undistilled pyroligneous acid was more effective than the distilled.

Germination of onion seeds was not injured by pyroligneous acid 6:100, 65 gallons per acre, applied to soil in the open row at the time of seeding. This treatment did not entirely prevent onion smut, however.

A dust containing 6 per cent glacial acetic acid (in diatomaceous earth), when applied to soil at the rate of 42.5 grams per square foot, afforded less complete protection against damping-off than did acetic acid applied in water to the soil. This dust applied to soil immediately before seeding did not injure the germination of beet and tobacco seeds.

Carnation Blight (*Alternaria dianthi* S. & H.). (E. F. Guba, Waltham.) Production of the best blooms was lowest with December cuttings and highest with March cuttings when benching was done on July 20, and this was influenced by a corresponding difference in the prevalence of both Alternaria blight and Fusarium wilt. Extensive observations in carnation nurseries in 1931 indicated a correlation between greater prevalence of disease and early propagation. Heavy rains in the summer of 1931 were an important factor influencing the losses from these diseases, but benching in advance of the heavy rains in July contributed greatly to their effective control.

In a test of the control of blight in the field with fungicides, Bordeaux 4:4:50 containing one pound of calcium arsenate and one-half pint of fish oil gave the best control. A spray of nicotine sulfate, salt, and fish oil, which is used occasionally to combat red spider on carnations under glass, was not an effective treatment for blight, and a spray of zinc sulfate, lime, aluminum sulfate, and fish oil, recommended in the Middle West for controlling the bacterial spot of carnations (*Bacterium woodsii* EFS), was of no value.

With the present crop, results have been obtained which show the value of using Bordeaux in the field. Results also show that early housing is of far greater value in the control of blight, and where practiced the use of fungicides in the field would appear not to be warranted.

Strawberry Gold Leaf. (E. F. Guba, Waltham.) This trouble is genetic and non-infectious, subject to modification by the environment. Seedlings of Howard 17 develop the characteristic symptoms of chlorosis. Degeneration of chlorophyll which is associated with this disease accounts for weak growth and often death. Badly chlorotic seedlings succumb soon after the leaves appear.

Adherence to asexual propagation from the original Howard 17 clon is apparently effective in avoiding the disease.

Forcing Gladiolus with the Aid of Artificial Light. (L. H. Jones.) In an effort to determine how many nights gladiolus (Crimson Glow) should receive artificial light (from 500-watt bulbs), a succession of plots was arranged to receive artificial light for one, two, three, and so on up to, and including, fifteen weeks. The check plot received no artificial light. Owing to poor soil, the results were not wholly satisfactory, but the trend of results checked with the results of previous experiments. Flowering spikes occurred when daylight was supplemented with artificial light in growing Crimson Glow planted in early autumn. Practically no flower spikes were developed when no artificial light was supplied. The greater number of flowering spikes was found in the group of plots that received the light for more than six weeks after the first leaf appeared above ground. Some flower spikes were developed in the plots receiving light for three and four weeks, and they bloomed earlier than flowering spikes receiving more light. This early blooming is consistent with previous results which have shown that, although artificial light aids in the development of flowering spikes, it also retards the date of blooming.

Plant Containers. (L. H. Jones.) In a continuation of the investigation of the effect of type of flower pot on plant growth, there has been no indication that the degree of soil acidity was altered in its range of fluctuation by either a non-porous wall or the absence of a drainage hole. Aeration of soils in both porous and non-porous types of flower pots takes place through the surface of the soil. By means of rubber vacuum discs, it was demonstrated that air did not pass through the wall of a moist clay flower pot. Two-thirds of the evaporation of moisture from fallow soils in clay pots on a dry surface took place through the wall of the pot, indicating that there was twice as much movement of water laterally as vertically. When the clay pot was on a moist surface, a considerable proportion of the moisture lost was replaced from the moist surface, and this replacement was inversely proportional to the amount of moisture in the soil of the pot.

Root development in the clay flower pot takes place, for the most part, adjacent to the inside wall of the pot. However, in plant containers of paper, glass, and metal, the root system ramifies through the soil mass with but a very small proportion of the roots occurring next to the wall of the container. The type and amount of root distribution is more closely related to moisture conditions in the soil, and possibly to nutrient relations, than to soil aeration.

Plant containers made of paper resistant to the decomposing action of soil organisms have proved satisfactory for the germination of seeds, production of seedlings, and development of plants. Paper pots made of heavy paper that decomposed, induced a nitrogen deficiency in the soil. However, if the paper was light weight, the pot was practically destroyed before a nitrogen deficiency occurred.

To moisten properly the soil mass in clay pots which became dry, two normal waterings were necessary. For non-porous containers, one normal watering was sufficient to accomplish the same object.

Nutrient Factors in Relation to the Region of Root Distribution in Plant Containers. (H. D. Haskins and L. H. Jones.) Preliminary work has laid the foundation for an investigation concerning the relation of nutrient movement in plant containers to moisture movement as influenced by evaporation forces. Bottom watering was followed by resulting incrustations on the surface

of the soil in the non-porous pots, but not in the porous pots. In the non-porous container, the only place where evaporation can occur is at the soil surface. In the porous pots, there is a greater loss of soil moisture through the wall of the pot than from the soil surface. It thus appears that the soluble salts move in the same direction as the moisture. Chemical analysis showed that, in soils in clay pots, the disappearance of nutrients became successively slower from the region near the pot wall to the center of the soil mass. In a porous or clay pot the most extensive root development takes place near the inner surface of the pot; while in a non-porous pot the root system ramifies throughout the entire soil mass.

Diseases of Outstanding Importance in 1932. (O. C. Boyd and W. H. Davis.)

Cherry bacterial blight (believed to be due to *Bacterium cerasi* F. L. Griffin rather than *B. pruni* EFS.).

Downy mildew (*Pseudoperonospora cubensis* (Berk. and Curt.) Rostew.) of summer squash and Blue Hubbard winter squash.

Anthracnose of watermelon caused by *Colletotrichum lagenarium* (Pass.) Ell. and Hals.

Twig blight and canker of *Juniperus sp.* caused by *Phomopsis sp.*

Bacterial spot of carnation caused by *Bacterium woodsii* EFS.

Peach scab caused by *Cladosporium carpophilum* Thuem.

Pear scab caused by *Venturia pyrina* Aderh.

Fire blight of pear, apple, and quince caused by *Bacillus amylovorus* (Burr.) Trev., largely confined to yard trees and neglected orchards.

Spur blight of raspberry caused by *Mycosphaerella rubina* (Pk.) Jacz. on Herbert and other red varieties; anthracnose caused by *Plectodiscella veneta* (Speg.) Burk. on both red and black varieties; *Mycosphaerella rubi* E. W. Roark, although not unusually prevalent on foliage, caused severe girdling of bearing canes of red varieties on Cape Cod.

Gray mold rot of strawberry caused by *Botrytis cinerea* Auct.; stunt, barrenness, and early dying of strawberry plants, apparently due to the disease, "dwarf" or "crimps," caused by the nematode, *Pathoaphelenchus fragariae.*

Bacterial wilt of cucurbits caused by *Bacillus tracheiphilus* EFS.

Downy mildew of cucumbers and muskmelons.

Wilt of winter squash caused by *Mycosphaerella citrullina* (C. O. Smith) Gross.

Early blight of celery caused by *Cercospora apii* Fresen.

Bean Blights caused by *Bacterium phaseoli* EFS. and *B. medicaginis phaseolicola.*

Downy mildew of onion (*Peronospora schleideni* Ung.).

Mosaic of tobacco.

Cytospora canker of Blue and Norway spruces, caused by *Cytospora sp.*

Peony blight caused by *Botrytis paeoniae* Oud.

Hollyhock rust (*Puccinia malvacearum* C. G. Bertero).

Delphinium black spot caused by *Bacterium delphinii* (EFS.) Bryan.

Tulip blight caused by *Botrytis tulipae* (Lib.) E. F. Hopkins.

Rose black spot caused by *Diplocarpon rosae* Wolf, and powdery mildew, *Sphaerotheca pannosa* (Wallr.) Lév.

Iris rhizome soft-rot caused by *Bacillus carotovorus* L. R. Jones.

Bacterial wilt of sweet corn, caused by *Aplanobacter stewartii* (EFS.) McC.

Smut, *Ustilago zeae* (Beckm.) Ung., caused more loss to corn than all other diseases combined and appeared to be more damaging than in the average season.

Late blight of tomatoes, caused by *Phytophthora infestans* (Mont.) DeBary, which ordinarily causes very slight or no damage in Massachusetts, assumed

epidemic form in September, and destroyed not only the last pickings of the early crops but practically all of the late fields in the eastern half of the State. In addition, it ruined varying portions of the fall crop in many greenhouses in the Boston Market Garden section. The disease did not reach the Connecticut Valley crops until shortly before the fields were abandoned because of freeze injury. The only previously reported occurrence of this disease in Massachusetts was in 1905, when the damage was slight.

THE CRANBERRY STATION

(East Wareham, Massachusetts)

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

Control of the cranberry root grub (Amphicoma vulpina). Some of the cranberry growers now have very efficient rigs for treating this pest with cyanide solution. Three-quarters of an acre a day can be treated with one of them at a cost of not over $55 an acre, with the present wage scale. However, this treatment never kills quite all of the grubs and so probably must be repeated in about ten years. Because of this and the cost of the treatment, it has seemed desirable to develop a control by flooding if possible. In this connection, the season's experience in the flooding of two badly infested bogs seems highly suggestive. On one of these bogs the full winter flood was held till July 4. This very late holding of the winter water failed to reduce the grub infestation noticeably. The winter flood was removed from the other bog on April 3, and the bog was reflooded again from May 16 to July 9, the water ranging from 6 inches to 2 feet deep over the sand surface. The temperature of the water of this reflow was taken in two widely separated locations carefully selected to represent average conditions, at depths of 6 inches and 1 foot, at 7 a. m. and 2 p. m. from May 27 to July 9, inclusive. The following table shows the range of these temperatures.

		Temperatures — °F.			
		At one-foot depth		At six-inch depth	
Months		7 a. m.	2 p.m.	7 a.m.	2 p.m.
May (5 days)	Highest	66	72	67	74
	Lowest	58	67	59	67
	Average	63	69+	62	70
June (30 days)	Highest	73	87	73	88
	Lowest	58	63	58	64
	Average	64+	74+	64+	76
July (9 days)	Highest	72	82	73	84
	Lowest	66	70	65	70
	Average	68+	77	68+	77+

So few of the grubs survived this reflow that they could hardly be found. It seems certain that the grubs were killed by the long reflow following, after a considerable period, early removal of the winter flood; but as the results of this treatment were so markedly different from those obtained by very late holding of the winter water, it should be tried further.

It was observed that the false blossom leafhopper (*Ophiola*) hatched in considerable numbers on both bogs after the late flooding operations described above.

Pyrethrum dust. (Dr. E. A. Richmond, employed locally by the Crop Protection Institute, cooperating.) The last annual report of the Cranberry Station con-

tained a brief statement of the results of tests to control certain cranberry pests with pyrethrum dust mixed with a gypsum diluent of 300-mesh fineness. All that dusting was done with hand dusters.

This year work with this dust was continued, but with a Root power duster mounted on a carriage home-made for use on cranberry bogs. In general the results of this work were highly satisfactory. The rig was drawn around on the bogs by two men, and they evidently injured the vines no more than spraying operations do.

Many tests were conducted in which different quantities of a mixture of the dust, made up of 1 part of pyrethrum and 9 parts of gypsum by weight, were applied in treating the false blossom leafhopper (*Ophiola striatula*). As little as 70 pounds to an acre gave a satisfactory kill in some cases; but because of the variation of pyrethrum in toxicity and of the difficulty of making an entirely even distribution of the dust, it was finally found that 100 pounds was about the right amount to use. Reasonably careful dusting with this amount of the mixture was commonly found to kill 99 per cent of the hoppers present. This treatment was a more effective and generally more satisfactory control for this insect than either spraying or flooding have ever been. It was also cheaper than spraying. Perhaps its most important advantage over flooding and spraying is that it may be applied without any risk when the vines are in full bloom and all the hoppers have hatched.

A dust mixture of 4 parts of pyrethrum and 6 parts of gypsum, by weight, used at the rate of 100 pounds to the acre, proved as effective as a pyrethrum soap spray for the control of the second brood of the black-headed fireworm (*Rhopobota vacciniana*) when the worms were small but rather well sewed up in the cranberry tips. This dust has not been tried against the first brood of this insect.

One part of pyrethrum to nine parts of gypsum, applied with hand dusters, was fairly effective in killing the moths of the cranberry girdler (*Crambus hortuellus*), but it is probable that a 2 to 8 mixture is advisable for this purpose.

Gypsy moth and contact sprays. The gypsy moth was very abundant this year in a large part of the Cape Cod region. As this prevalence came after several years of relative scarcity, it caught a good many of the cranberry growers napping, and bog infestations were rather generally neglected till the worms were considerably grown. This promised to develop into a serious situation, for stomach poisons are not effective on cranberry bogs against the caterpillars of this insect after their early stages, and very many bogs were without water supplies for flooding. Immediate attention was given to work with contact sprays, and it was found that the following sprays killed the worms in all stages satisfactorily when used at the rate of 400 gallons to the acre:

1. Pyrethrum soap	7 pounds	2. Nicotine sulfate	1½ quarts
Water	100 gallons	Soap	4 pounds
		Water	100 gallons

These sprays were most effective when applied early in the morning, for then the worms usually work in the tops of the vines where they are easily reached with a spray more than they do later in the day.

Nicotine sulfate and the cranberry fruit worm. It has become evident, as a result of spraying carried on in several seasons, that a nicotine sulfate spray at the end of the cranberry blossoming period controls the fruit worm to a considerable extent. As it has not been clear how it does this, special experiments were conducted, and it was found that the insect is affected by the spray in the three following ways:

1. Some of the moths are killed and many more are driven off of the sprayed area.

2. Most of the eggs well hit by a spray of 1 quart of nicotine sulfate in 100 gallons of water fail to hatch. This ovicidal action would be more valuable were it not so difficult to reach a high percentage of the eggs without running up the cost by applying a great amount of the spray.

3. Cranberry vines and berries treated with a spray of 1 1/3 quarts of nicotine sulfate in 100 gallons of water strongly repel the moths from laying their eggs for at least 5 days. This occurred in cages both in the laboratory and on a bog, the moths having been introduced some time after the treatment was applied and living in most cases till well toward the end of the test.

Control of the cranberry spittle insect. The general experience of cranberry growers and the results of the season's study indicate that it requires 1 1/3 quarts of nicotine sulfate and 4 pounds of soap in 100 gallons of water applied at the rate of 400 gallons to the acre to control this pest where water for flooding is not available. Pyrethrum sprays and dust fail to check it properly.

Weather Observations. (H. J. Franklin.) Daily local weather observations were made and reported to the office of the Weather Bureau at Boston. Further records bearing on frost forecasting were made for the station by observers at North Harwich, East Gloucester, Carlisle, Fitchburg, Worcester, and Holliston.

Cranberry Varieties. (H. J. Franklin.) The study of varieties was continued during the early months of 1932. A comparative study of their characters in detail, as related to their places of origin, revealed the fact that the native cranberry floras of New Jersey, the Massachusetts mainland, and outer Cape Cod have had significant separate evolutions.

Bog Irrigation. (H. J. Franklin.) On July 20, 1932, during a drought, a square area of bog surface of 100 square feet was wet with 150 gallons of water (about 65,250 gallons per acre), and on this plot two thermometers were placed a few feet apart with their bulbs at the same height as the cranberry flowers and young fruit (about 4½ inches above the bog surface.) For comparison two other thermometers were similarly placed on the bog about 30 feet outside the watered plot. All the thermometers were occasionally shifted in location to get as accurate averages of the relative temperatures as possible. The results were as follows:

Date	Weather Conditions	Hour	Average Temperature °F.		Difference between watered and unwatered °F.
			Watered plot	Unwatered Check	
July 20	Clear, slight breeze	2 p. m.	98.75	100.25	1.5
July 21	Clear, slight breeze	2 p. m.	97.50	99.75	2.25
July 22	Clear, strong breeze	12:30 p. m.	96.62	100.50	3.88
July 22	Clear, slight breeze	1:30 p. m.	95.87	98.92	3.05
July 23	Cloudy	2 p. m.	76.25	77.	.75

On July 23 a second plot, like the one watered on July 20, was wet with 150 gallons of water, and 25 gallons more were added on July 25 at 7 a. m. Two thermometers were placed on this plot also. The following table records the average temperatures on the two watered plots and the unwatered check.

Date	Weather Conditions	Hour	Average Temperature °F: Plot watered July 20	Plot Watered July 23	Unwatered check	Average difference between watered and unwatered °F
July 25	Clear, strong breeze	2 p. m.	92.25	92.38	96.91	4.59
July 26	Clear, strong breeze	12:30 p. m.	89.25	88.43	92.1	3.26

The general average difference in temperature between the watered and unwatered plots for five days (excluding one cloudy day when practically no difference occurred) was 3.08° F. Readings taken at different times of day indicated, as would be expected, that the greatest difference occurred in the early afternoon, i. e., during the warmest part of the day. It is interesting to note that even six days after water was applied to the first plot, the difference in temperature, in comparison with the unwatered bog, was as great as during the first day after application.

During the period when the berries were setting, considerable injury to the crop occurred on many bogs, for many flowers turned brown and dry and, of course, did not set fruit. Drought conditions caused most bogs to be unusually dry during the blooming season. The critical temperature above which cranberry flowers are injured is not known; but in view of the effect which watering has on the air temperature above and near the surface of a bog, as shown by the experiments just outlined, it seems probable that had the bogs been as moist as in normal seasons, the temperature might in many cases have remained below the point where injury occurs. How much this reduction of temperature is due to transpiration from the cranberry plants and how much to direct evaporation from the bog, it is impossible to say. Both these factors, however, depend more or less on the supply of moisture in the surface soil of the bog.

Cranberry Pollen Studies. (W. H. Sawyer.) Through a detailed study of the cranberry flower and pollination, several interesting facts have been developed.

Even during hot, dry weather, if pollination does not occur, the stigma remains moist and receptive for pollen for seven days, and under more favorable conditions of coolness and moisture, it is evident that pollination can take place for a considerably longer period. This is very significant on its influence in insuring a set. Also pollen must be thoroughly ripe before it is capable of germination, and such pollen is found only in anthers that have begun to shrink and turn brown.

When pollen is ripe it is shed from the anthers upon the slightest disturbance. A little pollen may be shed when the flower first opens, but maximum liberation takes place a few hours before the style has elongated enough to bring the stigma even with the anther tips. This occurs from twenty-four to thirty-six hours after the flower has opened.

The shape of the flower and the arrangement of the stigma and anthers are such as to supply reasonable justification for a lack of self-pollination. Distilled water was found to be as satisfactory as any other medium tried for the germination of cranberry pollen, but the pollen tubes did not grow very satisfactorily after germination. A 1 per cent solution of cane sugar was found to be the best medium for all purposes, and the best results were obtained when the pollen floated on the surface of the solution.

The range of temperature for pollen germination under laboratory conditions was 29°C.; with a minimum of 8°, the optimum from 28° to 32°, and a maximum of 37°. Within the temperature range where germination was possible, the percentage of germination remained constant, but there were variations in the time required, and these differences were also influenced by the variety.

It is evident from yield records of several varieties that there is a correlation between a high percentage of pollen germination and high yield, in spite of the fact that it would seem reasonable to assume that even the varieties with poor-germinating pollen would disseminate sufficient pollen to meet all "set" requirements.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

Frozen Fruits and Their Utilization in Frozen Dairy Products. (M. J. Mack and C. R. Fellers, Horticultural Manufactures.) This cooperative project has been active for three years. A full report of the investigation has been published in Bulletin 287.

The Vitamin C Content of Strawberry Ice Cream Containing "Frozen Pack" Fruit. (C. R. Fellers, Horticultural Manufactures, and M. J. Mack.) This study was planned to determine the Vitamin C potency of fresh strawberries, frozen packed strawberries, and strawberry ice cream. It was conceivable that Vitamin C might be partially destroyed either in the process of freezing, during storage, or in the rigorous beating of ice cream in the ice cream freezer. However, the data collected by feeding tests on guinea pigs indicate no destruction of Vitamin C either in the frozen storage of strawberries or in the preparation and storage of strawberry ice cream containing the frozen pack fruit. Thus strawberry ice cream may be considered a source of Vitamin C.

A Study of Ice Creams High in Fat Content. (M. J. Mack.) More data have been accumulated on this subject during the past year. Ice creams varying in fat content from 20 to 30 per cent are now being made by many New England manufacturers. Such ice creams vary markedly in character from the usual commercial product in which the fat content invariably lies between 10 and 20 per cent.

The most serious problem which is encountered in the making of high-fat ice creams is to control the viscosity of the mix. An excessive viscosity usually results which interferes with certain processes in making the mix, as well as with freezing and packaging of the product. Some sources of fat prove to be much more satisfactory than others in the control of viscosity. The findings thus far would indicate that, in the making of ice creams high in fat content, the percentage of non-fatty ingredients, as well as processing and freezing procedures, must all be altered wherever possible to bring about lower viscosity of the mix.

The Effect of High Initial Aging Temperatures on Certain Physico-Chemical Properties of Gelatin Dispersions. (W. S. Mueller.) The purpose of this investigation was to determine what effects various high initial aging temperatures have, when used for definite periods of time, on the basic viscosity and gel strength of gelatin dispersions. A gelatin-ice cream mixture, pure gelatin-water solution, and other gelatin dispersions such as cane sugar, butter oil, and plasma solids, were used. This study has been completed and a paper prepared for publication.

The following conclusions have been made:

1. When using a gelatin-ice cream mixture —

(1) Initially aging an ice cream mix for 1 to 6 hours at temperature range of 10° to 30° C. (50° to 86° F.), followed by a low aging temperature, increased the basic viscosity and gel strength over those mixes aged at the low temperature, 2.2°C. (36°F.) only.

(2) As the initial aging temperature is raised from 10°C. (50°F.), this increase in basic viscosity and gel strength reaches a maximum at 20°C. (68°F.), then decreases with further increase of the initial aging temperature.

(3) Initially aging an ice cream mix at or near the transition temperature of gelatin, 38.03°C. (100.5° F.), has no marked effect on basic viscosity and gel strength.

(4) Initially aging an ice cream mix at temperatures above the transition point of gelatin decreases the basic viscosity and gel strength when compared to mixes aged at the low temperature 2.2°C. (36°F.) only.

(5) The magnitude of the basic viscosity and gel strength changes increases with an increase in the initial aging temperature period. However, the first two hours produce the greatest change.

2. The effect of high initial aging temperatures on pure gelatin-water solution was similar to that on gelatin incorporated in an ice cream mix.

3. Sugar, plasma solids and butter oil had a marked influence on the magnitude of the basic viscosity increase due to the use of a high initial aging temperature, 20°C. (68°F.).

4. The observed effects of various initial aging temperatures on the basic viscosity and gel strength of gelatin systems indicate that the colloidal behavior of gelatin is affected by factors which are not generally recognized by current theories.

5. The observed increase in basic viscosity and gel strength, due to the use of a high initial aging temperature, points the way to a more economical use of gelatin in ice cream.

The Feasibility of High Aging Temperatures in the Manufacture of Ice Cream. (W. S. Mueller and J. H. Frandsen.) The object of this study was to determine the feasibility of using an aging temperature of 68° F. A four-hour high aging temperature period was selected as standard procedure. The 68° F. aging temperature was used alone and also followed by a low aging temperature. Each mix aged at 68° F. was compared to a portion of the same mix which was aged at 38° F. and served as the control. Comparisons were made on the following factors:

1. Bacterial growth.
2. Titratable acidity.
3. Hydrogen-ion concentration.
4. Basic viscosity.
5. Whipping ability.
6. Body and texture.
7. Melting resistance.
8. Melting appearance.

This study was completed during the past year and is now being prepared for publication.

The following conclusions were drawn:

(1) When an ice cream mix containing gelatin was aged at 68° F. for a period of 4 hours, either alone or followed by a low aging period, the efficiency of the gelatin was increased.

(2) This increased gelatin efficiency was shown by the improvement in body and texture, increase in melting resistance, and slight retardation in rate of whipping when compared to an identical mix aged at 38° F.

(3) When an ice cream mix containing 14 per cent fat, 10 per cent serum solids, 15 per cent sugar, and 0.4 per cent gelatin (175 Bloom) was aged at 68° F. for 4 hours, the efficiency of the gelatin was increased to such an extent that the gelatin content could be reduced 0.1 per cent without any loss in the quality of the finished product.

(4) Aging a pasteurized ice cream mix up to 6 hours at 68° F. had no effect on bacterial growth, pH, and titratable acidity which would be of any commercial significance.

(5) When an ice cream mix containing gelatin was aged at 68°F. for 4 hours, the basic viscosity was slightly decreased, but the basic viscosity was greatly increased when the high temperature aging period was followed by a low temperature aging period, as compared with a mix aged only at 38° F.

(6) When an ice cream mix containing no gelatin or other stabilizer was aged at 68° F. for 4 hours, there was no marked effect on the consistency and whipping ability of the mix or on the melting resistance, body, and texture of the finished product.

(7) When an ice cream mix containing the optimum amount of gelatin for low temperature aging was aged at 68° F. for 4 hours, there was an excessive retardation in melting and a curdled appearance on melting. This objectionable melting behavior can be corrected by a reduction in gelatin without lowering the quality of the finished product.

(8) It is conceivable that in ice cream plants where the cooling of mixes is not being carefully checked, mixes may be aged unintentionally for several hours at a temperature above 50° F. This unintentional high aging temperature in all probability is a big factor in causing the curdled appearance on melting which has troubled some ice cream manufacturers but could not be explained.

The Theoretical Causes of the Factors Involved in the High Initial Aging Temperature Phenomena. (W. S. Mueller.) In order to find an explanation for the structural changes in a gelatin gel, as a result of high aging temperatures, a detailed study of the optical rotation of pure 1 per cent gelatin-water solution was made. Gelatin-water solutions were aged at various temperatures (50°-122° F.) for a period of four hours and then at 36° F. for a period of 44 hours. The control solution was aged at 36° F. only, for a total period of 48 hours. The optical rotation was determined after a total aging period of 24 hours and 48 hours. The results so far obtained show that high initial aging temperatures have no marked effect on the optical rotation after a total aging period of 24 and 48 hours when compared to an identical solution aged at 36° F. only.

The following temperatures were used when studying the changes in optical rotation with time, until optical equilibrium had been obtained: 34.7°, 50°, 68°, 86°, 104°, and 140° F.

The effect of high aging temperatures on the Tyndall phenomenon of pure gelatin-water solutions is now being studied. It is hoped that these data, in conjunction with the optical rotation data, will bring to light a satisfactory explanation for the structural changes in a gelatin gel, due to the use of a high (68° F.) initial aging temperature.

A Study of the Changes that Occur in the Storage of Frozen Sweet Cream. (H. G. Lindquist.) Work has progressed on the preparation of cream for freezing, but no methods thus far have proved satisfactory in studying the changes that occur in the frozen cream.

The Comparative Efficiency of Electrically-operated Tanks versus Ice in the Cooling of Milk. (J. H. Frandsen.) A study of the efficiency of various methods of cooling milk, as practiced under actual farm conditions, is now in progress. The efficiency of most recent electric cooling units is also being studied.

DEPARTMENT OF ENTOMOLOGY

A. I. Bourne in Charge

Investigation of Materials Which Promise Value in Insect Control. (A. I. Bourne.) Weather conditions in the early spring of 1932 were favorable for application of oil sprays. There was very little interruption due to inclement weather. Moderately high temperatures prevailed at the time the buds were breaking, and no sudden drops in temperature were encountered sufficient to cause a breakdown of the sprays and consequent injury to the trees from the free oil liberated. No evidence of burn was noted following any of the oils tested.

Four oil emulsions and two miscible oils were used in the tests against European red mite. At the dilution of 4 gallons per 100, Kleenup gave 95 per cent control; Free Mulsion, 94 per cent; and Emulso, 92 per cent. Used at the rate of 5 gallons per 100, Kleenup showed 98 to 99 per cent control; Free Mulsion, 98 per cent; and Emulso, 95+ per cent. Peninsula Oil Emulsion, a new product on the market, at the strength of 4½ gallons to 100 gave 95 per cent control. The miscible oils, Dendrol and Sunoco, maintained their usual high degree of effectiveness, both showing 98+ per cent control at the standard dilution recommended by their manufacturers.

The present tendency in the use of oil sprays appears to be toward a comparatively few of the standard, well-established types which have been in use long enough to demonstrate their safety and effectiveness under Massachusetts conditions.

Preliminary tests with various insecticides for the control of the Mexican bean beetle indicated that magnesium arsenate, either as a spray or dust, is at present the safest and most dependable material on the market. Both lead arsenate and calcium arsenate caused severe burning, in most cases killing the plants. There is, however, some evidence to show that they might be used, if necessary, during the early season when both temperature and humidity are comparatively low. Barium fluosilicate caused a slight amount of foliage burn during midsummer. However, it showed possibilities for use on late string beans when arsenicals would be objectionable because of residue on the harvested crop. Some of the commercial products containing arsenicals combined with a fungicide proved effective against the insects and safe to the foliage of the beans. They are, however, somewhat expensive, especially if used on large plantings.

In cooperation with the Pomology Department, further studies were made of different "wettable sulfurs" designed to replace lime-sulfur in the midsummer sprays. The object of these tests was to find a spray that would prove effective against scab and compatible with lead arsenate, and at the same time would avoid the foliage burn and russeting of fruit which almost inevitably follows the use of lead arsenate and lime-sulfur in the post-blossom sprays.

Mulsoid sulfur, Dritomic sulfur and a combination of flotation sulfur and finely divided sulfur were used in combination with lead arsenate. The schedule followed called for a pre-pink, a pink, a calyx, a special curculio and a cover spray and two July applications for railroad worm. The standard lime-sulfur — lead arsenate combination was used on one block, as a basis for comparison. These wettable

sulfurs were used in all sprays after the special curculio spray. In the sprays up to the calyx spray, lime-sulfur was used as the fungicide.

Tests were continued with Kolofog and flotation sulfur, both of which showed great promise in 1931. Flotation sulfur was available for the first time in a dry powder form. This was much more convenient to handle than the paste form and proved fully as effective. It marked a distinct advance in the manufacture of this product. Kolofog and flotation sulfur (paste and dry) were used throughout the season in one-half of the block in which they were tested. The remainder of the trees received lime-sulfur up to and including the calyx spray and the new materials for the remaining sprays.

While the season was not particularly favorable for spray burn or the development of scab, considerable foliage injury followed the use of lime-sulfur, and unsprayed checks showed sufficient scab to infect nearly 60 per cent of the harvested fruit. No foliage injury or damage to fruit resulted from the use of any of the wettable sulfurs.

The value of these materials in controlling disease and insect pests is shown in the following table, based on examination of the McIntosh crop at harvest.

Treatment	Percentage of Clean Fruit	Percentage of Fruit Showing Injury From:		
		Curculio	Codling Moth	Scab
Lime-sulfur Lead arsenate	85	3	9	1
Lime-sulfur Lead arsenate Lime	95	1	2	0.5
Mulsoid sulfur Lead arsenate	83	5	4	0.8
Flotation sulfur 300-mesh sulfur Lead arsenate	91	2	5	1
Dritomic sulfur Lead arsenate	92	2	4	1
Flotation sulfur (dry) (entire season)	86	1+	3	6
Flotation sulfur (dry) after Lime-sulfur	96	0	2	1+
Flotation sulfur (paste) (entire season)	80	0.2	2	18
Flotation sulfur (paste) after Lime-sulfur	93	0.3	1	5
Kolofog (entire season)	89	0.5	3	6
Kolofog after Lime-sulfur	94	0.2	1-	4
Check	23	27	19	58

In these tests the lime-sulfur—lead arsenate combination gave equally good control of scab when hydrated lime was added, and the lime reduced the amount

of spray injury to fruit and foliage. Combined sprays of lead arsenate with Mulsoid sulfur, with Dritomic sulfur, and with the combination of flotation and finely-divided sulfurs held scab to 1 per cent injury or less and also controlled insect pests very satisfactorily.

The dry form of flotation sulfur proved as effective against scab as the paste and required much less time in the preparation of the spray. Kolofog again gave very satisfactory control of scab. Samples of fruit sprayed with these materials showed excellent quality and finish. The use of lime-sulfur as a fungicide in the early sprays followed by Kolofog or flotation sulfur in the midsummer applications gave a higher control of scab than that secured by a complete season's schedule of either of these materials. Spray injury was also avoided, and such a program would allow a material reduction in cost to the grower.

Control of Onion Thrips (A. I. Bourne.) Warm weather and a slight deficiency in rainfall during the early growing season offered favorable conditions for the development of thrips, and the very general practice of planting sets close to seed onions practically insured an early and heavy infestation on seed onions. By late June the number of thrips on seed onions was unusually high and some evidence of injury was appearing. Weather conditions during July sufficiently arrested the development of the infestation so that no serious damage resulted except in some fields adjoining set onions.

The insect was somewhat slower than usual in its seasonal development and reached the peak of abundance about a week later than normal. During early August there was a sharp drop in numbers of thrips per plant, from an average of 75 per plant on August 1 to less than 10 per plant on the 15th, and a gradual decrease until harvest.

It was discovered that this sharp decline in abundance of thrips was coincident with the appearance and spread of a parasitic fungus attacking the insects and the presence of an unusually large number of predacious insects. Examination of onion fields throughout the Connecticut Valley region showed that the fungus was generally present and that its development coincided with a rapid decrease in numbers of thrips. It could not be definitely proved that the presence of large numbers of predacious lady beetles was associated with the spread of this fungus. Coccinellids have, however, been reported to feed on spores of certain of the lower Cryptograms and their presence in abnormal numbers very generally throughout onion fields in the Valley offers a possible explanation of the general distribution and rapid spread of the fungus.

Throughout the growing season observations were made of different strains of onions, in connection with the work of the Agronomy Department on onion varieties, and a marked difference in reaction of various strains to thrips attack was noted. While no strain was found to be immune, certain types were scarcely affected by the feeding of thrips, which caused other types to curl badly and practically terminated their growth.

Comparative tests of nicotine sulfate, Derrisol, and a compound of rotenone in dust form indicated that nicotine sulfate sprays gave the greatest reduction in number of thrips, and their action was more rapid that that of other products. The derris compound was somewhat slower in its initial action than nicotine but appeared to exert considerable residual effect, which retarded reinfestation except that caused by migration of thrips from adjoining fields. The rotenone compound proved least effective of the materials tested, probably due to the fact it was in the form of dust which, with present machinery for application, does not penetrate the tight axils of the leaves as satisfactorily as a spray.

The Spray Residue Problem. (A. I. Bourne.) The dry weather that prevailed during the past summer again forced the problem of spray residue upon the attention of the fruit growers. The rainfall during June was nearly 1 inch less than the normal, and more than half of the precipitation for the month occurred in one storm. There was a deficiency of half an inch in July and of more than 1½ inches in August. While the rainfall in September was slightly greater than the normal, almost 60 per cent of this amount occurred in two storms late in the month when the McIntosh crop had been harvested. During October there was slightly more rain than normal. The fact that the greater part of the deficiency in rainfall occurred during the spraying season and extended up to time of harvest made the problem acute for early varieties and McIntosh. The precipitation in late September and October very largely removed the danger in the case of late varieties such as Baldwin. This deficiency in rainfall in itself was sufficient to make readjustment of the spray schedules necessary, but its effects were reflected also in the seasonal development of several important pests, notably railroad worm, which made proper timing of late sprays very difficult.

In many cases growers failed to apply the late sprays necessary for maggot control. Others made these applications only on late varieties. In both cases failure to control maggot resulted.

Growers who sprayed in late July or early August encountered the problem of residue on McIntosh in excess of the tolerance or dangerously near it. Growers who dusted in late summer again proved that this offers one of the most satisfactory solutions of the problem under Massachusetts conditions at present.

In preliminary tests a non-arsenical stomach poison showed to good advantage as compared with lead arsenate. This indicates a possible way out of the difficulty without forcing the growers to the practice of washing their fruit.

Systematic Study of Oil Sprays. (A. I. Bourne in cooperation with the Department of Chemistry.) The five samples tested this season were all prepared with the same emulsifying agents. The oils ranged from a spindle oil to a medium turbine oil and varied in their viscosity from 203 seconds to 619 seconds at 70° F. One sample was an asphalt base oil; the others were of the paraffin base type. These were applied as delayed dormant sprays in the college orchard, to test their comparative efficiency against overwintering eggs of European red mite and their toxicity to the trees. All the samples went into the spray solution without difficulty. They showed no tendency to break, even when dissolved in very cold water. Their efficiency as insecticides is noted in the following table.

Sample	Percentage of clusters free from mites	Number of mites per 100 leaf clusters
A3	55	70
B3	65	100
C3	60	87
D3	66	67
E3	66	73

All the samples gave practically perfect control. The differences above are too small to be of significance when compared with unsprayed trees which showed an infestation of more than 500 mites on single clusters and averaged more than 18,000 mites per 100 clusters. No injury to buds by burning of tissues or retarding of growth was noted.

Apple Maggot Control. (A. I. Bourne.) Apple maggot was more abundant throughout the entire State this past season and caused more damage than

has been reported in any year of its present period of abundance. The peak of emergence of flies was later than normal, and the flies were active in the orchards over a much longer period than usual. This was largely associated with the very light rainfall during late spring and early summer which left the soil dried and hard packed, a condition very unfavorable for the emergence of the flies. Under such circumstances proper timing of the sprays was difficult.

In the demonstration orchards where the growers were devoting especial attention to maggot control and carried out a complete control program, the pest was held to an average of less than 1 per cent damage. In the 14 blocks from which records were taken, 4 showed no fruit injured by maggot, and in 4 others the number of injured apples was 3 or less. In 7 of the blocks the fruit scored 85 per cent clean or higher, and in every case maggot injury was held to a lower figure than that of any other major pest.

One of the outstanding features of the season's work was the influence of orchard environment or, in other words, the necessity of proper treatment of neglected trees or orchards surrounding commercial blocks. Many growers found that even with the most thorough program possible they could not control maggot in their orchards because of the exposure of their blocks, on one side or more, to neglected apple trees.

The experience of the past season demonstrated that growers in whose orchards apple maggot is a problem must take suitable precautions to clean up their orchard surroundings, since the influence of orchard environment is in most cases the limiting factor determining satisfactory control of the insect or complete failure.

Introduction of Parasites of Oriental Fruit Moth. (A. I. Bourne.) During the last two years the Department of Entomology has cooperated with the U. S. Bureau of Entomology in the introduction and establishment of parasites of the Oriental fruit moth. Colonies of *Macrocentrus ancylivorus* were liberated in peach orchards throughout Hampden County where the infestation of fruit moth was sufficient to allow the establishment of the parasites.

Recoveries from twig collections indicated that the parasites were able to survive the winter of 1931-32 in Hampden County and build up a considerable population in the peach orchards the following spring. In orchards where liberations were made in 1931, a considerable reduction was noted in early twig injury the following spring, and growers reported beneficial results on the basis of the crop at harvest.

If a sufficient supply of parasites can be obtained, more extensive liberations will be made another season in other peach-growing sections of the State into which the fruit moth has now spread.

Plum Curculio. (W. D. Whitcomb.) Studies of the plum curculio under controlled temperatures maintained at 55°, 65°, 75°, and 85° F. were continued with special attention to influence of temperature on oviposition. The activity of ten pairs of mated beetles at each temperature was recorded daily.

The number of eggs laid increased at each higher temperature in an approximate ratio of 1:5:9:12, and about 75 per cent of the eggs were laid during the first 20 days of oviposition regardless of the temperature. Slightly more eggs were laid in the first 10 days than later, but the ratio of egg punctures to feeding punctures was about 4 per cent greater in the second 10-day period. At each temperature the last eggs were laid about 55 days after oviposition began. The average number of eggs per female per day laid during the first 20 days was 0.72 at 55°, 3.44 at 65°, and 10.21 at 85° F. The maximum number of eggs laid during life by one female

beetle was 41 at 55°, 169 at 65°, 240 at 75°, and 332 at 85° F., while the greatest oviposition in one day was 22 at 85° F.

Development of the immature stages was not completed at 55° and was very slow at 65° F. At 75° all development increased rapidly, and a slight additional stimulation occurred at 85° F.

When the beetles had only poisoned apples for food, the average number of days which they lived decreased with each increase in temperature and with each increase in concentration of lead arsenate from 3 pounds in 100 gallons to 4, to 5, to 6 pounds. The number of days in which the poison killed the beetles was quite consistent at the two higher temperatures, but at 55° and 65° F. the time was much more variable among individuals. The activity of the beetles was inconsistent when feeding on fruit sprayed with the lowest concentration of lead arsenate, but at the higher concentrations the average number of punctures per beetle before death decreased from 4.5 on 4 pounds to 3.3 on 5 pounds to 2.3 on 6 pounds of lead arsenate per 100 gallons of water with no consistent variation in respect to temperature. With one exception the average number of eggs per beetle was less than two in all fruit sprayed with lead arsenate at the rate of 4 pounds or more per 100 gallons. In the majority of the experiments no eggs were laid in sprayed fruit more than two days after the first activity took place.

The comparative effectiveness of spray and dust for the control of the plum curculio in apples was studied on Gravenstein at Westford. Applications were made by the grower at the recommended time. Examination of 43,568 apples showed 6.45 per cent of the dusted apples with curculio punctures and 2.80 per cent of the sprayed apples. A similar percentage in favor of the spray treatment was apparent in both the dropped fruit and harvested fruit.

Naphthalene as a Fumigant for the Control of Greenhouse Insect Pests. (W. D. Whitcomb.) Experimental fumigations with vaporized naphthalene in a tight chamber at the rate of 1½ ounces in 1,000 cubic feet resulted in practically perfect control of red spider nymphs and adults from one fumigation of six hours at 80° F. with relative humidities of 90, 80, 70, and 60 per cent. Two and three fumigations at 75° F. gave perfect control at each relative humidity. However, one fumigation at this temperature gave perfect control only at 90 per cent humidity, and the mortality decreased with each decrease in relative humidity from 80 to 60 per cent.

When the dosage was diminished to 1 ounce in 1,000 cubic feet the control was consistently satisfactory only after three fumigations, especially at 60 per cent relative humidity. The natural mortality of the red spider on these plants averaged 13.5 per cent.

The mortality of red spiders when exposed without napthalene for six hours to the humidities used in fumigating increased with each increase in relative humidity and with each additional exposure. Two exposures of six hours at 80° F. and 90 per cent relative humidity killed over 50 per cent of the red spiders without napthalene.

Biology and Control of the Carrot Rust Fly. (W. D. Whitcomb.) The potential infestation by the carrot rust fly in 1932 was 8.07 pupae per square foot where carrots were left in the ground over winter and was almost identical with a similar count (8.16) in 1931. However, the abnormally dry weather during June and July practically eliminated economic injury and prevented the building up of a normal second generation infestation. This condition was at least partially explained when none of the eggs confined at a constant temperature of 85° F. hatched while 85 to 90 per cent of them hatched between 55° and 75° F. No

flies emerged from overwintered pupae confined at 85° and only 44 per cent emerged at 75° F. The average date of emergence was 15 days later at 55° than at 75° F. Adults lived longest at 55°, and the largest number of eggs was laid at 75°, but 65° appeared to be the most favorable temperature for normal development.

In the field plantings there was no first generation injury in the untreated check and only one in 2050 carrots examined showed severe injury. The normal field infestation by the second generation was about 10 per cent most of which was slight and moderate, rather than severe. Celeriac was free from injury in comparison to other years when this plant suffered moderate to severe damage. Among new varieties of carrots which were observed for susceptibility, Table Gem and Tendersweet showed a tendency toward injury in spite of the light infestation. Under the existing conditions, broadcasted applications of tobacco dust and soot were very satisfactory when applied three times at weekly intervals, although the plots receiving two applications of these materials showed about the same infestation as the untreated check.

Influence of Temperature on Development of Red Spider. (W. D. Whitcomb.) The abundance of the red spider on greenhouse plants increased with the temperature, and on cool-growing plants such as carnation, injury by this pest can be reduced to a minimum by maintaining temperatures near 50° F. during cool weather. In experiments at 50° F. development of the younger stages was not complete, although some eggs were exposed for 57 days before it was determined that they would not hatch. The average number of days required for development from the newly laid egg to the adult was 29.1 at 60°, 12.4 at 70°, and 7.0 at 80° F. Eggs were hatched in 11.72, 5.35, and 3.53 days at the higher temperatures respectively, and over 90 per cent of the eggs hatched at these temperatures.

Although red spider eggs do not hatch at 50° F., there is a slight biologic development at this temperature which causes hatching in less than the normal period when the eggs are transferred to more favorable temperature. This biologic development varies directly with the length of exposure at 50° F.

DEPARTMENT OF FARM MANAGEMENT

J. A. Foord in Charge

Enterprise Relationships and Farm Organization on Selected Dairy Farms in Massachusetts. (R. L. Mighell.) Studies of the effect of replanning the labor program and the internal organization of enterprises on dairy farms have been continued. It has been discovered that significant savings in labor can be made in many farm tasks, for example daily chores, by means of careful planning. Frequently an inexpensive piece of equipment, or slight change in routine, will result in a considerable reduction of labor time. For example, on one farm the installation of an 18-foot extension of pipe line made a net saving in chore time of 13.4 minutes daily or more than 1½ hours per week.

Types of Farming in Vegetable Garden Areas. (R. L. Mighell, J. E. Thigpen. Cooperative with the Extension Service.) Records secured in the 1930 season have been further analyzed, and the amounts and distribution of labor used on different vegetable crops presented in tabular and graphic form for use in giving a more accurate picture of the types of farming in vegetable areas and in planning more profitable crop combinations. Variations in amounts of labor used for the same operations have furnished the starting point for the study of labor-saving methods and technique.

The Cost of Silage Production in Massachusetts with Special Reference to the Use of Machinery. (C. I. Gunness, J. A. Foord, and J. E. Thigpen. Cooperative with the Bureau of Agricultural Engineering, U.S.D.A., and the Departments of Farm Management and Agricultural Engineering of the Experiment Station.) The analysis of the data from a field study of silage-production methods made in October and November, 1931, shows definite relationship between man-labor inputs and acreage of silage corn, stoniness of the soil, and types of machinery used. The difference in amounts of labor required with and without certain machines can be used as measures of probable labor savings, assuming that other causes of variation in labor are averaged out.

Other basic data resulting from the study are farmers' estimates of annual repairs and probable life of different machines. These data are used in estimating average annual costs of such machinery. The annual costs can then be balanced against the estimated value of labor savings in case the purchase of a new machine is under consideration.

Economical Silage Production on Dairy Farms -- Labor and Machinery Costs. (R. L. Mighell and R. H. Barrett.) This study developed from the preceding one, as one of the most practical and at the same time most inexpensive pieces of labor-saving equipment in silo filling was found to be the low-rack wagon. Only four farms among the 64 studied used such wagons, but their average time for filling silo was only 1.6 hours per ton as contrasted with an average of 2.0 hours per ton for all the farms.

To test these results experimentally, an inexpensive low-rack wagon was built in the college engineering shop in September 1932, with a discarded automobile rear end for the rear wheels and axle and front running gear from an ordinary farm wagon. This wagon was tested under actual silo-filling conditions on the college farm and on four farms near Amherst. On three farms complete time records were taken on all operations. As a typical instance the time required to load silage corn on the low wagon was 23.6 man minutes per ton in comparison with 35.1 man minutes per ton with a wagon 41 inches high. (Average of 16 loads apiece). The low wagon is 22 inches high as compared with 38 inches to 50 inches for wagons in common use. With a low wagon, the corn can all be loaded from the ground without the necessity for anyone on the load. Recent studies in New Hampshire and Connecticut on this type of wagon are in line with these results.

Labor-Saving Methods and Technique on Vegetable Farms. (R. L. Mighell, R. H. Barrett.) This study is one of the first attempts to apply time and motion study methods to the operations on vegetable farms. Analyses of the motion pictures and time records secured in the 1931 season were continued this year, and further field study was directed particularly to asparagus, beets and carrots. As a result of the study of harvesting and packing operations on bunch beets and carrots a new and improved technique has been developed for these tasks. Typical tests of the new method of bunching and tying show that the time has been reduced from 5.3 man minutes per box with a common method now in use to 2.9 minutes per box with the new method.

With asparagus a new system of sorting and packing is being developed from ideas originally thought out by one grower. Preliminary tests indicate that the new system as adapted to fit different conditions will effect a reduction of one-fourth to one-third in the man labor needed on this job. Many minor changes such as rearranging labor crews, subdividing the work differently, providing convenient sorting tables and more desirable field boxes and so on, have been suggested

to growers in the field and tested out with success. Motion pictures have been very helpful in studying detailed operations in certain tasks and also furnish an effective means of presenting results to growers.

Live Stock Management, Methods and Costs. (J. A. Foord.) The positive reactors to the blood test for Bangs disease from the college herd have been kept in loose pens for three years, being "tied up" only for milking and grain feeding. The method has shown advantages in reduced hours of labor and amount of equipment needed, although with somewhat higher costs for bedding. Production has been well maintained, and clean milk of low bacterial count produced. Very little more floor space is needed than in the better type of stable. The method is worthy of consideration by practical dairymen.

FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

Feed Control (General Laws, 1920, Chapter 94)
Seed Control (General Laws, 1927, Chapter 94)
Dairy Law (General Laws, 1920, Chapter 94)
Advanced Registry Testing
Miscellaneous Work

Feed Control. (P. H. Smith, A. F. Spelman, G. J. Larsinos, J. W. Kuzmeski, F. A. McLaughlin, J. T. Howard.) During the fiscal year, 1,607 samples of feeding stuffs were officially collected and examined in the control laboratories. The results show that at least 97 per cent of the samples collected varied less than 1 per cent from stated guarantees in protein, fat and fiber content. The gross receipts from the registration of feeding stuffs in 1932 (calendar year) were $21,200, derived from 1,060 brands at $20 each.

Seed Control. (P. H. Smith, F. A. McLaughlin, Margaret E. Nagle.) From October 1, 1931, to October 1, 1932, the seed laboratory analyzed 1516 seed samples, 463 of which were collected by the State Department of Agriculture, 304 sent in by dealers and farmers and 194 by the Rhode Island Department of Agriculture, 354 purchased from wholesalers for special tests. The remaining 201 were accounted for in tests of ingredients of grass seed mixtures, some mixtures containing as many as eight ingredients.

	Massachusetts Official	Massachusetts Non-official	Rhode Island	Total
Purity only	41	26	53	120
Artificial germinations	257	572	3	832
Field germinations	0	(239*)	0	...
Purity and Germination	366	60	138	564
	664	658	194	1516
Field crops	32	61	18	111
Forage crops	375	140	173	688
Vegetables	257	446	3	706
Flower seeds	0	2	0	2
Tree seeds	0	9	0	9
	664	658	194	1516

*239 field tests are duplications of laboratory tests; portions of same samples used.

Field tests to determine trueness to type were again conducted in cooperation with the Department of Agronomy which tested 11 samples of alfalfa, 23 samples of red clover, and 3 samples of sweet clover; and the Department of Olericulture which tested 239 samples of sweet corn and 115 samples of peas.

Dairy Law. (P. H. Smith, J. T. Howard, J. A. Martell, H. L. Allen.) During the year ending December 1, 1932, 7,603 pieces of Babcock glassware were tested. Condemned glassware consisted of four milk-test bottles. One hundred and six certificates of proficiency were awarded.

One hundred and ninety-one creameries, milk depots and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, one machine was condemned, and repairs were ordered on twenty-five. Six plants were re-inspected to approve repairs. Special investigations were made at twelve plants.

Advanced Registry Testing. (P. H. Smith.) Advanced registry testing has been supervised by this department since its beginning in 1902. There are now on yearly test 483 cows located on 61 different farms. This does not include the herd tests where all animals in each herd are placed on test. Of these there are fourteen, five of which are supervised by men sent out from this office and nine by cow-test association supervisors.

Miscellaneous Work. (P. H. Smith, A. F. Spelman, J. W. Kuzmeski.) Numerous analyses have been made for residents of the State and other departments of the college.

Summary of Miscellaneous Work, 1932

Materials sent in:	
Milk and cream, butterfat only	362
Milk, solids and fat	29
Feeds	108
For other departments of Experiment Station and College:	
Milk, for butterfat	237
Milk, for solids	7
Dry matter, forage crops	3,196
Complete fodder analyses	169
Dry matter and nitrogen	116

FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

Fertilizer Inspection. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski.) Records for the year show that 106 firms have registered for sale in the State 537 brands of mixed fertilizer and fertilizing materials and 36 brands of agricultural lime and gypsum. The following summary shows the character of these substances, as well as statistics with reference to their inspection.

During ten weeks following April 1, four men employed to draw samples for inspection purposes sampled 23,827 sacks or containers, representing 8,136 tons of material; 848 agents were visited.

Products	Brands Registered	Brands Collected	Samples Collected	Number of Analyses	Number of Determinations*
Mixed fertilizers	333	322	1,128	480	5,760
Ground bone, tankage and fish	58	55	183	68	325
Nitrogen products, organic and mineral	56	50	307	195	396
Phosphoric acid products	28	26	111	29	116
Potash products	18	17	72	28	96
Dried, pulverized natural manures	23	22	101	23	115
Nitrate of potash	6	6	10	7	28
Miscellaneous	15	14	24	16	102
Lime products	36	34	72	39	334
Totals	573	546	2,008	885	7,272

*Not counting check tests or repeats.

During the period July 1, 1931, to July 1, 1932, the tonnage of fertilizer and plant food sold in Massachusetts was as follows:

	Fertilizer (Tons)	Plant Food Elements (Tons) Available Nitrogen	Available Phosphoric Acid	Potash
Mixed fertilizers	39,689	1,957	3,386	2,725
Unmixed fertilizer chemicals and materials	20,325	1,350	1,476	534
Pulverized natural manures	1,939	40	27	53
Totals	61,953	3,347	4,889	3,312

Full details of the fertilizer and lime inspection will be found in Bulletins 65 and 66, Control Series.

Miscellaneous Analytical Work. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski.) Cooperative chemical investigations have been carried on, as usual, with other departments of the Experiment Station, as well as with the Waltham Field Station and with County Agents. The character and extent of this work is shown from the following summary:

Celery leaves for mineral poisons	1
Complete fertilizers	1
Corn stover, ash analysis	33
Farm manure	1
Fertilizer chemicals and unmixed fertilizer materials	23
Hay, for partial ash analysis	59
Miscellaneous crops and crop residues for ash analysis	6
Oil emulsion	1
Soils, analysis of water extract of	15
Tomato pulp, dried, complete analysis	2

The usual variety of chemical work has been performed for farm organizations and state institutions, as well as individuals interested in agriculture. Reports of results have in all cases been accompanied by interpretations and advice with reference to the problems involved. This group includes the following materials:

Agricultural lime products	14
Ashes, cotton hull and wood	15
Complete fertilizers	20
Fertilizer chemicals and unmixed fertilizing materials	22
Insecticides and fungicides	3
Manures	8
Manufacturers' by-products	7
Miscellaneous	11
Peat products	19
Soils	37

Contact and cooperation with the Association of Official Agricultural Chemists has been maintained as in the past, in so far as rulings of the State Administration and the resources of the Control Department would permit.

Vegetation Pot Experiment with Phosphates. Season of 1932. (H. D. Haskins.) This experiment, comprising 101 pots in a study of the phosphoric acid availability of 20 different sources of phosphoric acid, has not reached the stage where positive conclusions are possible.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Study of the Effect of Plant Nutrients on Carnations and Roses Under Glass. (Harold E. White, Waltham.) Urea, Calurea, Cal-Nitro, and ammonium sulfate, when used as the source of nitrogen on a 4-12-4 basis, produced an average of 30 flowers per square foot of bench area, whereas sodium nitrate and calcium nitrate produced 25 flowers per square foot.

Where Calurea was used as a source of nitrogen in a 4-12-4 mixture, applied at the rate of from 1 ton to 4 1/2 tons per acre, there was a decrease of split flowers from 33 per cent to 5 per cent. This would tend to indicate that one means of lessening the tendency of carnations to split is by increasing the rate of application of fertilizers within certain limits. The production of carnation plants was increased from 18 flowers to 31 per square foot by increasing the rate of application of 4-12-4 from 1 ton to 4 1/2 tons per acre. Fertilizer applied at a higher rate than this resulted in a decrease in production. Carnations apparently will stand high application of fertilizers as long as the phosphorus and potash balance is maintained. Plots receiving as high as 10 tons per acre of a 4-12-4 showed no injury other than a reduction in production of flowers. The only exception was in the case of sodium nitrate where applications above 1500 pounds per acre resulted in a stunting of the plants, a reduction in the size of the flowers, and an adhesion of the flower petals. The adhesion symptoms did not occur in any other plots even though the rates of application were the same as for sodium nitrate; neither did dwarfing of the plants appear where the other materials were used in equivalent amounts. The soil reaction does not appear to be a factor where adhesion results from the excessive application of sodium nitrate, since in no case did the pH go above 7.0. The lowest pH, even where high applications of ammonium sulfate were made, did not go below pH 5.0. There was no noticeable effect of source of nitrogen or rate of fertilizer application on the rooting of carnation cuttings. Stem rot was present early in the season in the plots, but there appeared to be no correlation between feeding and severity of this disease on carnations.

Roses seem to give a better yield and make more vigorous growth where organic materials are used than when fed with straight commercial fertilizers. High application of chemical fertilizer reduces production and vigor of the plants.

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (Harold E. White, Waltham.) In the F_1 generation there was no consistent segregation for rust resistance sufficient for definite determination of the resistance factor. For most of the inbred lines studied, resistance to susceptibility approached a 1:1 ratio. With the F_2 generation resistance increased and, while the percentage varied, there was an approximate ratio of three resistant to one susceptible for total resistance. Resistance was so variable that color could not be correlated with resistance. Commercial strains which have been used for breeding have continued to show complete susceptibility to rust. Crossing commercial strains, while resulting in increased vigor, did not make the progeny less susceptible. Resistant strains crossed with pink varieties have resulted in complete susceptibility, even in the F_2 generation.

Double-crossed progeny in the F_1 generation did not show noticeably increased resistance to rust over the single-crossed progeny. The ratio of resistant to susceptible plants in the F_1 generation in both crosses was about the same. Susceptible strains in the F_2 generation gave all susceptible progeny. Susceptible plants from the F_1 generation continued to breed true for susceptibility in the F_2 generation. Between eight and ten thousand plants were grown in the F_2 generation test; selections from these strains are being carried on for the F_3 generation.

DEPARTMENT OF HOME ECONOMICS

Bernice Wait in Charge

The Comparative Value of Milk and Tomato for Supplementary Feeding in Elementary Schools. (B. Wait and M. V. Cowing.) For the past three years the children in a small consolidated rural school have been given a supplementary mid-morning feeding at first of either milk or tomato and later of a combination of evaporated milk and tomato juice. The study is being continued for a fourth year by feeding the children of a control school to ascertain whether any results of the feeding which seemed apparent can be duplicated in this latter group. Whether the data obtained will confirm the observation that there was some improvement in the general well-being of the children as a result of the feeding of either the tomato or the milk or of both, or whether the apparent improvement was sufficient to be measured by the tests applied can not be stated until the analysis of these data has been more nearly completed.

The Value of Evaporated Milk for School Food Service. (B. Wait and O. A. Merriam.) This project is similar in purpose and in method to the above. Throughout two school years the children of the first four grades of the school in a small mill village have been given a mid-morning feeding of eight ounces of reconstituted evaporated milk daily. The general condition of these children at the beginning and the end of the school year as indicated by medical and dental examinations, and their growth, school progress, school attendance, and incidence of colds during the school year have been observed. These same observations have also been made of a control group of children of the same grades in a school in a neighboring village. As in the project above, the control group is being fed this year to ascertain whether any improvement observed in the general well-being of the children of the experimental group can be obtained as well in the children of the control school.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

Technological Investigation and Nutritive Value of New England Fruit Products. (C. R. Fellers and J. A. Clague.) Apple juice extracted within a few seconds by means of a small centrifugal extractor proved to be a very satisfactory beverage, though differing materially in color, flavor, and consistency from pressed sweet cider. The fresh juice darkened rapidly and formed a fine sediment. Both freshly made and 24-hour-old juices had lost 10 to 30 per cent of the vitamin C content of the original fruit. Pasteurized cider and strained apple sauce retained practically no vitamin C, while benzoated cider and unstrained apple sauce retained 20 to 40 per cent of the vitamin C. In the Baldwin apple, the vitamin C is concentrated in the epidermis and in the fleshy cortex. The epidermis is about 4 times as active as the flesh near it, and 6 to 10 times as active as the flesh in the pulpy area near the core.

While the Baldwin apple is a rich source of vitamin C, the McIntosh is very poor. When 25 grams a day were fed to guinea pigs, there was some scurvy protection and bare maintenance of weight.

Baldwin apples had lost about 20 per cent of their vitamin C content after 4 to 6 months storage at 36° F.; after 8 to 10 months the loss had reached nearly 40 per cent.

Ten leading New England varieties are now being tested for vitamin C.

Manufacture, Preservation and Nutritive Value of Cranberry Products. (C. R. Fellers and J. A. Clague.) Approximately 50 varieties of cranberries were again examined chemically and made into strained and whole-fruit sauce. Many varieties were found unsuitable for manufacturing purposes. In fact, a blend of several varieties gives the best cranberry sauce in point of flavor. Data were collected on the manufacturing methods employed by canners and preservers of cranberry products. For canning cranberry sauce only well-tinned re-enameled cans will satisfactorily preserve the flavor and color for a year at room temperatures. Corrosion and perforation of the can, and discoloration of the sauce are greatly reduced at storage temperatures of 32° to 40° F. Either slow or quick-frozen cranberries can be used for sauce manufacture. The canned sauce made from frozen berries kept in storage for one year was fully equal in quality to that made from fresh fruit.

Vitamin studies made by P. D. Isham, aided by funds furnished by the American Cranberry Exchange, have further proved the high antiscorbutic value of the fresh and frozen cranberry and whole-fruit cranberry sauce. Strained sauce, pasteurized juice, jelly, and evaporated whole cranberries retained very little vitamin C. Cranberries were shown to contain about 0.2 rat unit per gram of vitamin A. Negative results were obtained for vitamins B, D, and G.

Additional blood and urine examinations were made on young men fed measured quantities of cranberries. The blood alkali reserve was not significantly decreased unless 5 ounces or more of cranberry sauce was eaten. The conjugation of benzoic and quinic acids in the body produced urinary acidities in proportion to the amounts of cranberry ingested, though 5 ounces or less of cranberry sauce produced relatively slight increases in either the H-ion concentration or the hippuric acid. These results indicate that moderate or even generous servings of cranberries may be eaten without fear of reducing the blood alkali reserve to a dangerous degree.

Cranberry juice has been prepared both by the cold-pressing and heat-extraction methods. For cold-pressing, the berries should be ground and allowed to stand in a cool place for 12 to 24 hours to increase the color of the pressed juice.

The yield is about 3.5 gallons of pure juice to 50 pounds of fruit. The clarified diluted juice with the addition of sugar makes a very satisfying beverage and one not at present marketed. The heat-extracted juice is already being manufactured on a commercial basis in this State.

Cranberry jelly has never been a satisfactory commercial product. The jelly is soft and watery. This objection has been entirely overcome by treating the cold-pressed or heat-extracted juices with pectinase enzyme to remove the quick-setting cranberry pectin. This is followed by filtration and the addition of citrus or apple pectin. A perfect jelly retaining all the flavor and color of the cranberry is thus obtained.

Effect of Microorganisms on the Jellying Power of Fruit Juices. (C. R. Fellers, J. A. Clague and R. L. France.) The several species of yeasts and bacteria employed to date do not decompose pectin in fruit juices. However, several species of Penicillium and Aspergillus are very active pectin decomposers. Juice or pulp harboring these actively growing molds will not make satisfactory jelly or pectin.

Utilization of Onions by Canning and Drying. (C. R. Fellers.) This project has been inactive during the year except insofar as canned, dried, and pickled onions, previously packed, have been examined for keeping quality. There has been much commercial interest shown in the onion powder from cull onions which was developed several years ago.

Utilization of New England Fruits in Ice Cream. (C. R. Fellers and M. J. Mack. A report of this work was published in July as Bulletin 287. This cooperative project has been continued with a view to ascertaining whether strawberries still retain vitamin C after freezing and storage and incorporation into ice cream. Results clearly indicate that the high vitamin C content of fresh strawberries is retained in both frozen strawberries and strawberry ice cream.

Research on Dates. (C. R. Fellers, J. C. Clague and M. M. Cleveland.) The mineral composition of dates was determined and published in *Industrial and Engineering Chemistry, Analytical Edition*, 4:267-268, July 1932.

The souring of dates was found to be due to the growth of sugar-tolerant yeasts. Some of the results were published in the *Journal of Bacteriology* 23:63, January 1932.

This work was made possible by a grant from the Hills Brothers Company of New York.

Vitamin Content of Blueberries. (C. R. Fellers and P. D. Isham.) Native, Maine, and Newfoundland blueberries were examined for vitamin C content, funds to help in this work having been furnished by the Birdseye Laboratories of Gloucester. The native tall-bush blueberry, fresh, frozen, or canned, was a good source of vitamin C, about 4 to 5 grams daily sufficing to protect guinea pigs from scurvy. However, the Maine and Newfoundland low-bush blueberries were not over one-third as active in this vitamin.

Effect of Fertilization on Vitamin A and C content of Asparagus. (C. R. Fellers, R. E. Young and P. D. Isham.) With the financial assistance of the Potash Export Company, My., asparagus grown at the Waltham Field Station was tested for vitamins A and C. The first season's results show that asparagus is a rich source of vitamin C, from 2 to 2.5 grams daily fully protecting guinea pigs from scurvy. The fresh asparagus also contained 5 to 7 units of vitamin A per gram. No conclusions may yet be drawn as to the effect of fertilizer treatment on vitamin content.

Canned Red Squill Rat Baits. (M. G. O'Connor and E. M. Mills, Bureau of Biological Survey, U. S. D. A.) This research, financed by the K-R-O Company of Springfield, Ohio, has shown that beef or horse meat, whiting, mackerel, haddock, and cereals, when mixed with red squill powder and canned, proved to be acceptable yet toxic baits for rats. Proper sterilization processes have been worked out for these canned baits.

DEPARTMENT OF OLERICULTURE

Ralph A. Van Meter in Charge

Asparagus Investigations. (Robert E. Young, Waltham.)

Fertilizers. The asparagus plots located at Waltham on a rather heavy soil did not produce as high yields in 1932 as those located on the lighter soils at Concord and Eastham. The spears at Waltham were very small, but the number of spears per plant was large. Older asparagus growing in another bed adjacent to these plots produced a large percentage of fancy spears, while almost no spears large enough to be graded as fancy were produced on the fertilizer plots. Nitrate of potash and sulfate of potash did not give as good results as muriate of potash. The difference in yield of the plots receiving the various nitrogen carriers was insignificant. Results this year show that potash is necessary for high yields.

The plots at Eastham, Massachusetts, on a light, gravelly soil gave very good results. Yields were high and the proportion of fancy spears was much greater than at Concord or Waltham. The plot receiving seaweed and superphosphate remains the highest-producing plot in the experiment, probably due to the capacity of this plot to hold moisture and plant food. Ten of the plots are duplicated on an acid soil. Some of the fertilizers gave better results on the acid soil, but ammonium sulfate gave only about 60 per cent as great a yield as on the regular plot.

The plots at Concord were cut for a period of two weeks this year. Last year they were not cut, due to poor growth of the previous season. The yield was very good for the short period of harvest. The plot that produced the highest yield was one receiving cottonseed meal as the source of nitrogen. This was followed closely by the plots which received the nitrogen as sulfate of ammonia and the phosphorus as basic slag. The remainder of the plots are grouped very close together in yield. The plot receiving no potash was notably low. Acidity tests made late in the fall show that the average pH has been raised from 4.5 to about 5.8.

In general the results obtained this season are much more promising than those of last season. There were some substitutions made in the fertilizer materials used, one being the use of calcium cyanamid, superphosphate, and potash in place of a mixture of ammonium phosphate and potash. The cyanamid was applied at the regular time, June 20. At that time there was a very heavy crop of weeds about three inches high covering the ground. A few days after this application of about 750 pounds of calcium cyanamid per acre, the weed growth had been completely killed. It apparently did not affect the asparagus plants.

Depth of Planting and Height of Cutting. The most significant result of this experiment seems to be the increased mortality where the asparagus roots are planted 6 and 8 inches deep. The decreased number of plants in these plots has reduced the yield. The roots planted at the shallow depth of 2 and 4 inches produced by far the most asparagus. If the yields are computed on the basis of a 100 per cent stand, however, the roots planted 8 inches deep rank first in yield, followed by the plots where the roots were planted 2, 4, and 6 inches deep, respectively. A

comparison of the stand counts in 1931 with those in 1932 shows that in the plots where the roots were planted 2 and 4 inches deep there was almost no loss of plants; while the plots where the roots were 6 to 8 inches deep continued to lose plants, there being approximately a 6 per cent loss in the latter case.

Of the three plots where the spears were cut with 4, 8, and 12 inches green, the largest yield was obtained from the plots cut with 12 inches green, and the plots with 8 inches of green were next. Yields from the plots cut with 4 inches of green were 11 per cent below the yields of the 12 inches of green. The yields this year were about the same as in 1931 except that the spread between the 4 inches and the 12 inches green was not so great. Definite conclusions cannot be drawn until the results of two or three seasons are available.

Seed Improvement. (Robert E. Young, Waltham.) Selfing to obtain pure lines was continued on five of the most promising strains of blue Hubbard squash. Some of these strains are nearly pure as shown by the uniformity of shape, color, wartiness, and thickness of flesh. These strains are losing vigor in that they do not produce yields equal to those of commercial strains. Some F_1 plants were grown from the cross of the most promising strains last year. The plants were selfed in order that a pure strain may be obtained if they continue to show promise.

The 1931 selections of Horticultural beans grown this past season proved to be a great improvement over any commercial variety that has been tried here. Two of these selections were very superior, and it is the intention to develop them further.

The market gardeners purchased about 750 pounds of the Field Station Hutchinson carrot seed this year. It is reported to be superior to commercial strains. There is some variation in the length of the carrot when it is grown in various types of soil. Plenty of this seed is available for distribution in 1933. The parent stock is being maintained at the Field Station to insure the same quality of seed from year to year.

The red sport of Oshkosh pepper that has been grown at the Field Station for the past few years has now been named the Waltham Beauty. The uniformity of the fruit of this pepper was greatly improved by the selections made in 1931. In 1932 there were plants among the selections that bore 20 marketable fruits. Plants grown on a one-eightieth acre plot for yield data produced an average of 12 peppers per plant, and the average weight of the peppers was 3.7 ounces. Selections were continued to improve the uniformity of the plants in height. Crosses made in the greenhouse last winter between the Waltham Beauty and the California Wonder, in the hope of producing a larger pepper, increased the size but at the expense of yield. As the Waltham Beauty seems superior to the varieties grown by the market gardener, it was decided not to wait until the pepper is perfected to distribute samples of the seed.

An ample supply of seed of the Bel-May lettuce is now available. Last season, 125 pounds of seed were grown in California for the Boston Market Gardeners Association. Plants are now being grown to maintain the seed stock, and from these selections will be made in an attempt to improve the frame formation.

Selections have been continued to improve the color and flesh of the Wyman Crosby beet. This variety has already proved to be very uniform in shape and size. The beets produced from the stock seed are uniform in shape and size and maintain their quality until quite large. Selections were made last season on the basis of size and color, as there seemed to be some indication of a correlation between them.

Systematic and Quality Studies of Varieties of Sweet Corn. (G. B. Snyder.) In the trial plots, 231 lots of sweet corn including 82 different named sorts were grown. Detailed records of each lot were taken in order to allow for definite classification and rating as commercial varieties for Massachusetts market gardeners. Many lots having distinct names were found to be either very similar to or synonymous with older standard varieties. Comparatively few of the varieties studied were found to be satisfactory for culture by the market gardener from a consideration of maturity, yield, size of stalk, size of ear, and color, size, and quality of kernel.

Refractive indexes and percentage-of-sugar readings were taken for 211 lots, 20 readings being taken for each lot. In the pre-milk stage of development sugar ranged from 12 to 16 per cent, and from pre-milk to soft-dough development varieties differed markedly, the high point in sugar ranging from 16 to 29 per cent. Strains of a variety, however, deviated very little from the average for the variety in percentage of sugar.

This year was the first of a three-year project.

Dark Center or Internal Breakdown of Swede Turnips. (G. B. Snyder and R. W. Donaldson.) Dark center of the Swede turnip is apparently physiological in character and non-parasitic. Histological studies indicate the condition as brownish or water-soaked areas in the parenchyma tissue between the vascular strands. The tissue of the cortex and cambium is not affected. In the advanced stages of dark center, the affected tissue becomes pithy and woody.

Field studies of dark center did not show any relationship between the condition and fertilizers, soil acidity, soil type, or crop rotation. A definite relationship, however, was noticed between soil moisture and dark center.

Series of crocks were set up in which varying quantities of animal manures and peat were applied to soils taken from infected fields in Berkshire and Barnstable Counties. In each series the soil moisture was regulated at low, medium, and high points. In every case the high organic soils having a medium to high moisture content produced plants showing little to no dark center. The low organic soils having a low percentage of moisture produced plants, the roots of which were decidedly affected by the disorder.

Taxonomic Studies of Eggplants. (G. B. Snyder.) During the past five years, 105 different named lots of eggplants have been under observation in the trial plots. Detailed records have been taken of each lot for plant and fruit characters, disease susceptibility, and commercial adaptability. From these observations and records a systematic monograph is being prepared.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

J. B. Lindsey in Charge

The Effect of Fertilizer and Cultural Treatment on the Composition of Havana Tobacco. (E. B. Holland and E. Bennett.) Various grades of Havana tobacco raised on the station plots in 1931 have been analyzed with a view to determining the effect of different amounts and forms of applied nitrogen on the composition of the web of both cured and sweat samples. The scope of the work has been broadened to include the determination of carbohydrates, with the expectation that additional studies may show some correlation between the nitrogen-carbon ratio of the web and its free-burning qualities.

To supplement this investigation popular brands of smoking tobacco and of cigarettes have been purchased in the local market and submitted to analysis.

The results show marked differences in the pipe tobaccos but a reasonable uniformity in the cigarette tobaccos.

Oil Sprays. (E. B. Holland.) Miscibles were prepared from five different lubricating oils ranging from spindle oils to a medium turbine. The process employed was the so-called spontaneous method using triethanolamine oleate as the emulsifying agent. The miscibles were applied in the orchard on the basis of 3 per cent oil by weight and gave satisfactory control of mites (index) in all cases with no apparent injury to buds or retardation of growth. The heavier, more viscous oils required a larger amount of emulsifying agent at an increased cost and were no more effective.

Nitrogen Fixation in the Presence of or as a Result of the Growth of Legumes versus Non-Legumes Under Certain Defined Agronomic Conditions. (F. W. Morse.) The crops grown this year (1932) were Hungarian millet and soy beans as non-legume and legume. Nitrogen was applied this year to Plots 5, 8, and 10, while Plots 7 and 9 were continued without any as in the past 50 years. This was the ninth crop since the beginning of this experiment, during which period Plot 6 has not received nitrogen while in previous years it had been dressed with ammonium sulfate like Plot 8.

Dry Matter and Nitrogen Removed from Non-Legume and Legume Areas in 1932
(Pounds per acre)

	Without Nitrogen		With Nitrogen	
	Dry Matter	Nitrogen	Dry Matter	Nitrogen
Hungarian Millet	3464	28.24	5385	52.78
Soy Beans	4029	104.77	4377	99.43

The non-leguminous millet responded to the nitrogen fertilizer with an increase of 1921 pounds of dry matter, equivalent to 2260 pounds millet hay per acre. The gain in nitrogen was 24.5 pounds, which is only 55 per cent of the 45 pounds applied per acre.

The leguminous soy beans gained 348 pounds of dry matter when nitrogen was applied, but the crop contained less nitrogen than that grown without any nitrogen in the fertilizer. The failure to take up nitrogen from the fertilizer has been observed in previous seasons with clover.

A summary of the nine crops grown on the legume sections of all the plots is here presented for each year of the experiment.

Dry Matter and Nitrogen removed from Legume Areas in 9 *Years*
(Pounds per acre)

		Without Nitrogen		With Nitrogen	
Year	Crops	Dry Matter	Nitrogen	Dry Matter	Nitrogen
1924	Clovers	3865	106.1	*3916	100.6
1925	Corn	3419	59.4	3422	58.5
1926	Soy Beans	3491	79.6	*3681	87.9
1927	Corn	2366	39.4	2353	40.9
1928	Clover and Weeds	2658	39.0	*2828	38.7
1929	Clover	3952	91.6	3624	81.3
1930	Millet	6187	78.9	*6920	89.5
1931	Peas and Oats	2510	44.6	2579	46.8
1932	Soy Beans	4029	104.8	*4377	99.4
	Total	32477	643.4	33700	643.8

*Nitrogen applied in each of these years at the rate of 45 pounds per acre.

The net gain in nine years by the application of 225 pounds per acre of nitrogen was 1223 pounds of dry matter, while the nitrogen contained in the crops practically balanced. The fertilizer nitrogen appeared to stimulate growth at some stage, due possibly to its immediate availability, without ultimately increasing the content of the element except in the non-leguminous crops interspersed in the series. The leguminous crops from the plots without nitrogen, four times out of six, contained more nitrogen than those from the nitrogen group.

The results of this fertilizer experiment are now being prepared in more detail for publication. They suggest a new comparison between atmospheric nitrogen compounds synthesized by bacteria and those synthesized by factory processes by continuing the legumes and non-legumes, but substituting the newer nitrogen compounds for the former standard fertilizers.

Chemical Study of Cranberries. (F. W. Morse.) Twenty-three varieties of cranberries were analyzed, ten of which were from Wisconsin and thirteen from New Jersey. The samples were procured by Dr. H. J. Franklin in connection with his comparative studies of cranberry varieties. No information was available regarding dates of picking from the vines.

The analyses were made during January of this year (1932), and the berries were removed from cold storage as needed. Water, total sugar, and total acid were determined. Eight varieties were below 3 per cent in sugar content, which indicates fruit immature when picked. Eleven were between 3 and 3.5 per cent and one contained 4 per cent total sugar. Total acid ranged from 2.05 to 2.71 per cent which is within the limits found in past seasons.

Two varieties were notably superior in the proportion of sound fruit in January. Searls Jumbo from Wisconsin and Budds Blue from New Jersey were more than 85 per cent sound when sorted by hand. Fourteen were less than two-thirds sound, which shows the risk in holding cranberries in storage to extend the market period.

The two varieties above named illustrate the comparatively narrow difference in chemical composition between extreme types of cranberries. Searls Jumbo is a juicy berry of high quality. Budds Blue is dry and firm in texture. Analysis gave the following results in percentages.

	Water	Total Sugar	Total Acid
Searls Jumbo	87.9	4.02	2.33
Budds Blue	86.6	2.61	2.20

Astringent matter was determined in several varieties, of which these two represented the extreme range — Searls Jumbo, 0.19 per cent; Budds Blue, 0.37 per cent. The astringent matter in the cranberry appears to consist of a glucoside with a bitter taste rather than tannin, although qualitative tests show traces of tannin to be present.

Quinic acid was determined in 13 of the varieties by the tentative method mentioned last year. The range in approximate percentages was from 0.38 to 1.03 per cent. The two varieties mentioned above were practically alike, with approximately 0.7 per cent of the acid.

In the course of the cranberry studies, a quantity of the cranberry wax has been accumulated for the purpose of studying its properties.

Milk Substitutes in the Growing of Young Calves. (J. B. Lindsey.) This project has been completed and the manuscript prepared for publication. The general conclusion was that it is quite desirable to feed calves some liquid food until they are two months of age, and the time can well be extended a month

or more in case of delicate calves or when an extra growth impetus is desired. Nothing better was found for this purpose than powdered skim milk, now easily obtainable in the market at a reasonable price, followed later by white fish meal combined with our grain ration No. 5. The detailed method of procedure is given in the publication.

Two Systems of Dairy Cattle Feeding — High Roughage and Low Grain versus Low Roughage and High Grain. (J. B. Lindsey and J. G. Archibald.) This investigation has been completed and the results published in Bulletin 291.

Mineral Requirements for the Growth of Dairy Heifers. (J. B. Lindsey and J. G. Archibald.) Eighty-eight metabolism balance trials have been completed with twelve heifers on high and low phosphorus rations. The results of seventy-two of these trials with eight of the heifers have been calculated and sufficiently interpreted to enable determination of the next logical step in the investigation; but publication of even tentative conclusions at this time is not deemed justifiable.

Studies in the Chemistry of Pasture Grasses. (J. G. Archibald and E. Bennett.) A final report of three years' work on the chemical composition of grass from pasture plots managed according to the Hohenheim system appeared in the *Journal of Agricultural Research* 45: 627-640, November 15, 1932.

Results of a study of the distribution of the different forms of nitrogen in pasture grass have been brought together in an article entitled "Nitrogen Partition in Pasture Grass", which has recently been submitted for publication in the *Journal of Agricultural Research*, together with a companion article entitled "Influence of Drying and Grinding upon the Total, Amino and Ammonia Nitrogen Content of Grasses."

Field work in connection with the survey of natural pastures throughout the State was completed this year. One hundred samples of grass have been collected from typical unfertilized pastures on predominant soil types in the five western counties of the State. The analytical work on these samples is in progress and will be completed within a few weeks.

The study of the chemical composition of various species of grass has been continued this year. Forty additional samples from well-established plots of timothy, red top, Kentucky and Canada bluegrass, orchard grass, sheep fescue, Rhode Island bent, and white clover have been secured during the year, and reliable data are gradually being accumulated. The work will be continued at least another year before a formal report is made. However, the following tentative observations seem warranted at this time:

1. Orchard grass (*Dactylis glomerata*) has a remarkably high mineral content, phosphorus being about double that found in any other grass studied, and calcium being considerably higher than in most of the others.

2. The bent family of grasses (*genus Agrostis*), represented in this study by red top (*Agrostis alba*) and Rhode Island bent (*Agrostis canina*), seems to be characterized by a high content of calcium.

DEPARTMENT OF POMOLOGY

F. C. Sears in Charge

The experiment station orchard produced another good crop of peaches in 1932 following a remarkably mild winter. The lowest temperature reading in the orchard was exactly zero. During the ten years that this orchard has been of bearing age, the crop has failed only in 1924 and 1927, the cause of failure being

winterkilling of the fruit buds. Evidently the killing point is usually close to -15° F. Buds, especially of bud-hardy varieties, may withstand lower temperatures, while those of the more tender varieties may be badly killed at higher temperatures. The severity of bud killing depends on (1) the minimum temperature, (2) the variety, (3) the condition of the tree, and (4) conditions prevailing at the time of the temperature drop, such as wind, the rapidity of the drop, and the duration of the low temperature.

The apple crop was about 60 per cent larger than that of last year but was exceeded by that of 1930 also by about 60 per cent. Damage from insects and diseases in all well-sprayed orchards was unusually light.

The Interrelation of Stock and Scion in Apples. (J. K. Shaw.) Due to financial stress the Department has been obliged to allow the control of the main orchard of this project to pass to a commercial grower. Limited observations will still be made, but detailed experimental studies become impossible. Applications of muriate of potash to certain rows have not yet shown clearly that the "tip burn" referred to in the report of last year is due to potash deficiency. Observations on this will be continued. It is evident that water supply is a factor, but it is possible that lack of potash may also be a factor.

The young orchard of McIntosh and Wealthy on East Malling stocks set in 1928 continues to develop in a satisfactory way. It bore a scattering crop this year. McIntosh on Malling Stock 1 gives indications of being superior in early production, while Wealthy on the same stock does not produce so much on account of the very small trees. Stock 16 maintains its position as a standard stock and has produced well. Stock 9 promises to be a good dwarfing stock. The largest crop of Wealthy was on trees on Stock 4, and only McIntosh trees on Stock 1 exceeded those on Stock 4. This stock is not very highly regarded in England and may develop some fatal weakness, but experience thus far seems to indicate that here it is a good stock for producing large trees and for early production with these two varieties.

These stocks are being further multiplied, and more extensive tests of our desirable varieties on them are planned. It seems possible that some of them may be desirable for producing semi-dwarf trees, free from the objections to dwarf trees, which may have commercial value.

Tree Characters of Fruit Varieties. (J. K. Shaw and A. P. French.) The set of photographs and technical descriptions of more than 100 commercial varieties of apples referred to last year has been practically completed. Work along a similar line with commercial varieties of cherries has been started. Trees or buds of nearly forty varieties have been assembled. Seedlings of Japanese flowering cherries have been used as stocks. Certain types of this species produce viable seeds abundantly and give vigorous seedlings resembling Mazzard stocks. Further experience will show whether these are desirable for cherry stocks.

The usual certification work of the Massachusetts Fruit Growers' Association and the inspection of nursery trees for trueness to name have been continued although in somewhat reduced volume as compared with earlier years, due to the reduced demand for trees. The significance of this work is shown in the almost complete absence, now, of misnamed trees in the nurseries examined; whereas in the early years they were present, literally in thousands. The nurserymen report a marked reduction in the complaints of misnamed trees received from customers during the last few years. Such complaints must practically disappear in the future. The nurserymen having these examinations represent a rather small proportion of the total number; but the influence of this work extends beyond the

nurseries actually examined and there can be no doubt that the number of misnamed trees sold has been greatly reduced.

The Genetic Composition of Peaches. (J. S. Bailey and A. P. French.) Evidence has been obtained that in peaches there is linkage between the gene controlling stone adhesion and the gene controlling flesh toughness, with about 8 per cent crossing over. The Champion variety has an albino lethal character which acts as a simple Mendelian recessive. Among certain seedlings a new combination of leaf characters has appeared. Some individuals have very wavy leaves, deeply serrate margins, and globose glands. A paper on "The inheritance of certain characters in the peach" which is to appear in the 1932 *Report of the American Society for Horticultural Science*, will discuss these observations in more detail.

The breeding work was continued in the spring of 1932. This work was planned so as to give further information concerning the linkage relations between stone adhesion and toughness of flesh. Favorable weather conditions prevailed during the breeding season and a good crop of pits was obtained.

The two orchards of seedling peaches planted in 1928 had to be removed in the fall of 1932 because of a severe infection of peach yellows.

As a result of the peach breeding work in 1931, about 300 seedling peach trees are in the nursery ready to be set in the orchard in the spring of 1933.

Testing Methods of Pruning. (J. K. Shaw.) One of the orchards involved in this work has passed into the hands of a commercial grower for reasons previously mentioned. Some observation on the orchard may still be made. Work in the other orchard is still continued with no change in the trend of results.

Effect of Pruning Bearing Apple Trees. (J. K. Shaw and O. C. Roberts.) This experiment in an old bearing orchard has continued as in earlier years, comparison being made between heavy, light, and no pruning. Sizing and grading tests show in some cases better color and larger size in the apples from pruned trees and occasionally less insect infestation and disease, but the differences continue to be less than most fruit growers would expect.

Observations have been extended to include certain Rhode Island Greening, Wealthy, Ben Davis, and McIntosh trees, 35 years old, some of which are moderately pruned while others are left unpruned.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw.) The amount of nitrate of soda applied to the sod plots was increased in the Spring of 1932 from 300 to 400 pounds per acre. There is some evidence that this may have resulted in yields larger than they would have been without this increase. Yet the plot in cultivation with nitrate continued to make a better showing; this gives further evidence that the sod-nitrogen program will not, over a period of years give maximum yields. The McIntosh trees on the cultivated nitrate-potash plot continue to yield better than those on the similar plot receiving nitrate alone, while the Baldwin trees do not. The increase in McIntosh is about 70 per cent, while the Baldwin trees have shown little or no increase. Further evidence is needed before it is safe to conclude that McIntosh has more definitely a potash requirement than Baldwin; yet it may be true.

The younger orchard included in this project has passed out of our control as previously stated.

Comparison of Clover Sod and Grass in a Sod Mulch Orchard. (J. K. Shaw.) The fertilizer treatments were continued as in previous years. The grass has been allowed to grow and the white clover has almost disappeared from

the phosphorus-potash-lime plots. These plots continue inferior to the complete fertilizer plots in yield. There is no conclusive evidence that the white clover brought in by the phosphorus-potash-lime treatment has benefited the trees, yet the trees have apparently produced better than they would have done had no fertilizer been applied. Wagener seems to have suffered more from lack of nitrogenous fertilizers than have Oldenburg and Wealthy.

Tests of Different Amounts of Nitrate of Soda. (J. K. Shaw.) This project has continued on the modified plan of fertilizing only in the off-bearing years. A complete fertilizer is used which contains nitrate of soda at the rate of 10, 17½ and 25 pounds per tree. The orchard is in sod. The crop in 1932 was less than that of 1930. This may have been due to weather conditions, the probable cause of the rather light Baldwin crop in 1932, or the omission of fertilizer may been have a factor. It is uncertain as yet whether this omission has improved the appearance of the fruit. Yields continue to be larger with larger amounts of nitrogen, and there is no marked difference in color of fruit.

Comparison of Cultivation and Heavy Mulching for Apples from the Different Plots. (J. K. Shaw.) The cultivated plots which received no fertilizer before 1931 were fertilized with nitrate of soda this year as in 1931. There is an apparent increase in yield of McIntosh, but Wealthy shows little if any increase. The yield of McIntosh, considering the smaller size of the trees, is now nearly if not quite as good as that from the mulched trees. The standard Wealthy trees on the cultivated plot with nitrate show some gain from the nitrate but those on doucin stock do not. This may be because they were already producing up to their limit. The comparison will be continued.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw.) The own-rooted McIntosh and Wealthy trees planted in 1931 have made fair growth, and the fertilizer applications were continued the same as last year. Conclusions as to whether these trees will behave the same as those previously grown on this field cannot yet be drawn.

Role of Potash and Lime in Fruit Tree Nutrition. (J. K. Shaw.) Further studies on the effect of acidifying soil from the long-time fertilizer test field known as the North Soil Test by applications of sulfur showed that lowering the pH value below 5.0 usually injures the growth of the seedling peach trees used as indicators, while lowering it below 4.0 kills the trees. The addition of mineral fertilizers is likely to be of little or no benefit, while the addition of organic ammoniates favors growth even in rather acid soils. Trees in soil from an apple orchard where apple trees are growing well, grew well under a pH of 4.2; however, when the pH was lowered to 3.8 the trees failed to grow. Raising the pH by additions of lime favored growth as in previous years.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw.) This project has been carried on as in past years. There seems to be no evidence that lime has been of any benefit to the trees. It is possible that the addition of potash to nitrogen has now increased yields though there was no evidence of it in the earlier years. No indications of benefit to the trees from the application of phosphorus have yet appeared. More data and a careful analysis of all of it is necessary before final conclusions can be drawn.

Study of Varieties of Fruits. (J. K. Shaw and O. C. Roberts.) More new varieties came into bearing than in any previous year. Some are promising but few will take any prominent place among the standard varieties.

The Macoun apple bore more abundantly than in previous years. It is of good size and is nearly, if not quite, as good in quality as McIntosh. It is a real winter apple and fairly attractive in appearance. Its very short stem will cause no stem-bruises in the package. It is superior to Cortland in most respects. It seems to be the most promising candidate for a place as the much desired "Winter McIntosh."

Lobo is very attractive in appearance, being of a clear bright red but its quality is much inferior to McIntosh. As it is of nearly the same season it seems doubtful whether it can find a place in Massachusetts.

Early McIntosh and Milton showed no distinct superiority over previous years and it seems doubtful whether either becomes very valuable here.

Lodi is larger than Yellow Transparent and probably will stand handling a little better, but varieties of this type do not seem to be now in favor.

A red sport of Gravenstein originating in Ashby came into bearing this year. It is similar to the Washington type sent out by the New York Fruit Testing Association but does not seem in any way superior to it. Another sport, received from Lunenburg, while of somewhat higher color than Gravenstein, shows too little superiority to be very valuable.

Gallia Beauty again proved far superior in color to both Rome and Red Rome. The basin is wider, deeper, and more abrupt than in Rome, but otherwise it is similar in tree and fruit. There seems to be good reason why Gallia Beauty should replace Rome where such a variety is desired.

Melba is of Duchess season and superior to it for eating. It ripens unevenly and does not stand handling well. It may have value for local and roadside stand trade. Brock, Joyce and Pedro, three other McIntosh seedlings originating at Ottawa, are inferior in color and not too good in quality.

Scions claimed to represent a red and a blushed strain of McIntosh, topworked in the same tree, bore this year and proved the claim well founded. Apples of one strain were clearly striped and splashed while those from the other showed no sign of stripes or splashes. There was little difference in the total amount of color, yet the blushed strain is probably more desirable.

The raspberry variety plantation suffered badly from winter injury in 1931-32. Early in the spring the canes seemed in good condition but the leaf buds failed to start and the canes died back or were entirely killed. Some varieties suffered more than others. Newburgh and Monroe showed little or no injury. Possibly the rather severe cold in late winter and early spring following an unusually mild winter caused this injury.

The following varieties of red raspberries, originated at the Geneva New York Experiment Station, fruited in 1932:—

Newburgh has shown no mosaic as yet though other varieties located nearby have suffered more or less severely. It is vigorous, a good plant maker, and a heavy producer in mid-season of large firm berries of good quality. It is very promising.

Monroe (No. 2568). This variety also has as yet shown no mosaic diseases. It is vigorous, a good plant maker with practically smooth canes. It is a good producer, ripens its large, attractive, firm fruit early, and is of good quality. It is promising.

Nos. 2563, 2564, 2490 and 2491. These are similar to Monroe but all have suffered from mosaic diseases. The fruit ripens later and is poor in quality. They do not promise well here.

Some other varieties which fruited this year are as follows:

Lloyd George is vigorous and a good plant maker. It has not suffered from

mosaic but has shown some cane and spur blights. It ripens early and produces fairly well; the fruit is very large and of fairly good quality. It tends somewhat to be an everbearer. It should have value for the home garden.

Viking is vigorous and a good plant maker but suffered much from mosaic and winterkilled badly, seriously reducing the yield. When it does not winterkill it produces heavily of medium to large, firm berries of good quality in mid-season.

Chief is vigorous, a good plant maker, and has shown no mosaic. Fruit medium to large and of excellent quality. It is a good producer in mid-season, and seems very promising.

During the past season 41 varieties of strawberries were under observation. The following seemed to have desirable characteristics:—

Aberdeen is vigorous and a good plant maker. It is productive. The fruit is medium to large in size, attractive, medium to dark red in color, ripens from mid-season to late. It is worthy of a trial for both commercial and home use.

Bliss is one of the varieties originated at the New York Experiment Station. It is vigorous and a good plant maker, but somewhat susceptible to leaf spot. It ripens in late mid-season. The berries are large, attractive and of good quality.

Bouquet, also from the New York Experiment Station, is similar to Bliss but is earlier in season and seems to produce more heavily.

Commonwealth is an old variety but still worthy of consideration as a late variety which is its outstanding feature. It is moderately vigorous with light green foliage. It is fairly productive of large conic berries of fair quality.

First Quality is another old variety which maintains its popularity mainly because of its high quality. It is a fairly good producer of medium-sized berries in mid-season. It is susceptible to leaf spot.

Howard 17 (Premier) is too well known to need recommendation here.

Howard Supreme (Howard 25) is a newly introduced variety which continues to be one of the highest producers in the plantation. It is vigorous, dark green, and an excellent plant maker. The fruit is medium to large, dark red with red flesh and of good quality.

Mastodon continues to be the outstanding everbearer in the plantation. It is a good plant maker and a good producer of medium to large berries.

Steven's Late Champion is a good late strawberry but only fairly productive.

The following varieties are of questionable value in Massachusetts for the reasons given:

Beacon - lacking in vigor and a poor producer.

Dunlap - small size of fruit.

Edmund Wilson - poor producer.

Improved Heflin - lacking in vigor, fruit small and of mediocre quality.

Town King - very poor in quality.

May Beauty - lacking in vigor; not productive and of only fair quality.

King Edward - excellent in quality and size, but lacking in productiveness; of value only for the home garden.

Marshall - the standard of quality but extremely unproductive.

Some other varieties grown, but concerning which there is yet insufficient evidence to judge their true worth, are seven varieties from the New York Experiment Station: Caledonia, Camden, Clermont, Culver, 4433, 4734, and 4813; also the Jupiter and Wyona.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter.) This project is concerned with the effect on fruit-bud formation of nitrogen applications at various times during the latter part of the growing season. It was continued

during the past season along lines similar to those of the past four years. There has been no measurable effect where the plants are grown on the hill system with plenty of space between the plants.

A new bed was set in the spring of 1932 in which runner plants were developed and treated with nitrogen-carrying fertilizers. Nitrogenous fertilizers were also applied to alternating sections of strawberries in matted rows to study the effect of crowding upon nitrogen response. All plots are duplicated five times and all receive phosphorus and potassium.

Bud Mutations. (J. K. Shaw and W. H. Thies.) The collection of bud mutations of apple varieties was maintained. It will be several years before they come into bearing so that any persistent characteristics and their value can be determined.

Storage of McIntosh Apples Under Various Conditions. (O. C. Roberts cooperating with C. I. Gunness and W. R. Cole.) This project involves a study of the effect of the "blast" system of cold-air distribution on the keeping of McIntosh apples. A study is also being made of the optimum humidity for the satisfactory storage of apples in the cold storage and the air-cooled storage. Observations are being made in several commercial refrigerated and common storages in addition to those made in the college plant.

Study of Various Spray Materials. (O. C. Roberts cooperating with A. I. Bourne.) This is a continuation of the work that has been carried on here for several years whereby various spray materials on the market are given practical tests in the orchard to determine their efficiency and safety to the trees. Several of the wettable sulfur compounds appear to be suitable substitutes for liquid lime-sulfur in the post-calyx applications.

Blueberry Culture. (J. S. Bailey.) The propagation of blueberry plants was continued to increase the supply of plants, particularly of the newer varieties.

In the spring of 1932 a start was made on the establishment of a large plantation for the study of the cultural requirements of the blueberry. Observations on the relation of height of water table to the growth of blueberries were begun in this plantation.

The variety blueberry plantation was considerably enlarged to facilitate the more extensive testing of varieties under local conditions.

Cross Pollination and Sterility Studies with Certain Apple Varieties. (F. C. Sears, O. C. Roberts and others.) Work on the question of pollination of apples was continued for the eighth season. Special emphasis was placed on Macoun and Cortland, the two new varieties about which orchardists are most anxious to secure information. Both these varieties seem to be promising as pollinators for other varieties, but the evidence so far would seem to indicate that Cortland is inclined to be self sterile, like its parent the McIntosh.

DEPARTMENT OF POULTRY HUSBANDRY

J. C. Graham in Charge

Broodiness in Poultry. (F. A. Hays.) Non-broody and intense broody lines are continued. Both lines are being selected for the same degree of early maturity, intensity, absence of winter pause, and persistency. These lines will eventually differ only in the presence or absence of the broody instinct during the pullet laying year. In the 1931 generation there were 43 birds in the non-broody line. Of this number, 33 or 76.74 per cent were non-broody the first year and

their average annual egg production was 230 compared with an average production of 208 eggs for the 10 individuals going broody. The broody line was made up of 30 individuals. Three, or 10 per cent, were non-broody the first year. The mean egg production of the 30 birds was 177.

Deferred broodiness or the failure of the broody instinct to appear until after the first laying year causes considerable difficulty in the selection of breeding stock that is phenotypically broody or non-broody in the two lines.

The study of the mode of inheritance of degrees of broodiness is being continued as well as a study of the relation of broodiness to other characters affecting fecundity.

Breeding Poultry for Egg Production. (F. A. Hays and Ruby Sanborn.) The mean annual egg production of the last generation of this experiment was 221 eggs. The mortality rate in the laying houses was 34 per cent without culling and with all sisters of the families included. This flock was superior for intensity, but there was a greater percentage of broody birds than in the previous flock.

Egg size is being increased without the loss of high fecundity but more slowly than would be necessary if high intensity were given less consideration. Hatching records for 1932 were unsatisfactory because of a defective incubator.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn.) Data have been prepared and published as follows: "Early and late feathering in Rhode Island Reds," *American Naturalist* 66: 286-287, 1932; "Types of intensity in Rhode Island Reds," Bulletin 286; "The relation of feather pigmentation to intensity of laying in Rhode Island Reds," Bulletin 288; "Hereditary and environmental factors affecting variability in egg production," Bulletin 289; "Relation between body weight and age at sexual maturity in Rhode Island Reds," *Poultry Science* 12:23-25, 1933; and "Relation of weight at sexual maturity to annual egg production," *Poultry Science* 12:25-26, 1933.

A Genetic Study of Rhode Island Red Color. (F. A. Hays.) The third generation of crosses between exhibition and production-bred Rhode Island Reds is now being carried in the laying houses. The F_1 generation was intermediate in plumage color, yet showed a rather wide range of color. The mean annual egg record of this generation was 191.

The F_2 generation exhibited the extreme range in color of the parent stock. The mean annual egg record of these birds was about 157.

The F_3 generation came from mating $F_2 \times F_2$ and from mating F_2 to parental stock. There is very definite segregation both of color pattern and of fecundity traits.

Determination of Genetic Laws Governing Results of Inbreeding. (F. A. Hays.) The first generation of daughters hatched in 1929 from sire on daughter matings averaged 180 eggs with a mean age at first egg of 216 days. The second generation from half-brother x sister matings had an average annual egg record of 190 with a mean age at sexual maturity of 192 days. A third generation of 24 birds hatched in 1931 had a mean annual production of 196 eggs and a mean age at first egg of 213 days. None of the third generation daughters in one of the three inbred lines could meet the standard for breeders and this line became extinct with this generation.

The value of inbred males mated to unrelated females to test prepotency is now being studied.

Factors Affecting Egg Weight and Shell Character in Domestic Fowl. (F. A. Hays.) The fifth generation of birds was hatched in 1932. The criterion

for selecting pullet breeders to produce this last generation was the ability to lay 52-gram, 57-gram and 59-gram eggs during the month of November. Previously these egg weights applied for the month of December. The daughters in these three lines are mated to three full brothers of distantly related stock each year. Egg size is being increased in all three lines but at a very slow rate in the 52-gram group.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Elimination Law. (H. Van Roekel, K. L. Bullis, O. S. Flint, and Miriam K. Clarke.) During the 1931-32 pullorum disease testing season, 420,861 blood samples were tested by the macroscopic tube agglutination method. This number represented 377,191 chickens in 455 flocks. Among the samples tested, 0.90 per cent were positive. This is the lowest percentage of positive tests ever attained in this State. No positive tests were recorded in two counties. In six other counties there were less than 1 per cent of positive tests. The number of non-reacting flocks was increased to 355. Of these, 180 flocks, representing 157,516 birds, were 100 per cent tested. No reactors were detected among 1,034 birds other than chickens. These birds were distributed among 25 flocks. Chickens were tested on 19 of these premises, and reactors were found in five of the chicken flocks. Necropsies were performed on 117 birds for 61 flock owners. The necropsy service has been found valuable in determining the pullorum disease status of a flock in which only doubtful reactors are detected.

Pullorum Disease Investigations. (H. Van Roekel, K. L. Bullis, O. S. Flint, and Miriam K. Clarke.) Results of recent investigations concerning jellied blood samples, susceptibility of pheasants and guinea fowl, agglutinins in young chicks, avenues of infection, a comparison of diagnostic tests, and the most efficient use of the agglutination test in eradication are reported in Control Bulletin 63.

Laboratory Service - Pathology. (G. L. Dunlap and K. L. Bullis.) During the year, 1,042 specimens were examined for 263 people, of whom 96 made personal calls at the laboratory. The specimens were distributed as follows: — 1,013 chickens, 3 pigeons, 8 guinea pigs, 4 swine, 6 rabbits, 2 turkeys, 2 ducks, 1 calf, and 1 mink. The diseases encountered most frequently were pullorum disease, rachitis, so-called "range paralysis", parasitism, and tumors. Tuberculosis was diagnosed in one turkey and in one hen.

Farm and Station Bang Disease. In assisting this project, the laboratory tested 1,371 blood samples by the tube agglutination method.

Infectious Laryngotracheitis. (C. S. Gibbs.) The studies on chronic carriers of infectious laryngotracheitis have been completed, and 22 chronic carriers have been found in approximately 1,000 birds examined by intratracheal swabs. The length of time virus was eliminated by these carriers varied from 37 to 741 days.

Immunity studies have been continued through the year. It has been determined that immunity to infectious laryngotracheitis is acquired by direct contact with the causative agent and is not transmitted to the offspring, except in rare instances where the hens have laid eggs for hatching while passing through the acute stages of the disease. Also it has been found that infectious laryngotracheitis is primarily a disease of pullets and cockerels, older birds being more or less immune to it. This natural resistance should not be confused with artificial immunity.

Several methods of vaccinating pullets and cockerels against infectious laryngotracheitis have been studied, and the bursa of Fabricius appears to be the most satisfactory site for inoculating birds with attenuated viruses. The immunity produced by vaccination in the bursa of Fabricius is not lasting in all cases unless a standard vaccine is used. As yet no simple, inexpensive process for standardizing the vaccine for infectious laryngotracheitis has been discovered, and for this reason no practical method for vaccinating birds on a large scale is recommended.

Four spraying solutions recommended for infectious laryngotracheitis have been tried out in the laboratory to determine their pharmacological action upon the respiratory system. These sprays were not found specific for infectious laryngotracheitis, since they did not destroy the virus in the tracheas of acute cases and chronic carriers.

A plan for the eradication and control of infectious laryngotracheitis has been worked out by laboratory studies and field tests and is recommended until a more satisfactory way of handling the disease is discovered. The plan follows:

The Massachusetts Plan for the Eradication and Control of Infectious Laryngotracheitis

1. All birds on the premises that have had infectious laryngotracheitis or been exposed to it should be condemned and disposed of at the end of the hatching season or at any other time most convenient to the owner for the expedient eradication of the disease.

2. Incubators and brooders should be cleaned, disinfected, and isolated some distance from the condemned birds.

3. Chicks that have not been exposed to infectious laryngotracheitis may be kept for restocking, provided they are entirely separate from the condemned birds and the premises occupied by them.

4. All buildings occupied by the condemned birds should be thoroughly cleaned and disinfected as soon as possible after they are vacated.

5. The houses and yards after cleaning and disinfecting should be opened to the air and sunshine and left vacant for two months or longer.

6. Overalls and shoes worn around the condemned birds or on the premises occupied by them should not be used in the houses, on the range, handling feed, or in caring for chicks for re-stocking, unless laundered or thoroughly disinfected.

7. Utensils and equipment used around the condemned birds or in cleaning and disinfecting the premises occupied by them should not be used in the houses or on the range where the chicks for re-stocking are kept unless said utensils and equipment have been thoroughly cleaned and disinfected.

8. Permitted Disinfectants should be used as directed for disinfecting all poultry houses, utensils, and equipment.

9. New stock should be introduced only from absolutely clean flocks or from the poultrymen's own hatchings which have been adequately protected from infection.

10. The subsequent re-introduction of infectious laryngotracheitis should be carefully guarded against.

Twenty-seven poultrymen are known to have tried the plan as recommended or some modification of it. Twenty-three of them succeeded in eradicating the disease completely and four failed. The four failures were found to be due either to improper cleaning and disinfection, or to the lack of sufficient airing and sunning of the house and yards.

Infectious Bronchitis. (C. S. Gibbs.) An epizootic of infectious bronchitis, due to a streptococcus, has been found affecting a flock of hens and roosters. The

causative agent was isolated from the bronchial tubes and tracheas of infected birds by means of blood agar plates, and transmitted in series to susceptible fowls and roosters, and successfully recovered from each case.

Culturally, morphologically, and serologically the streptococcus resembles the microorganism isolated from a similar condition in baby chicks reported in Bulletin 280, p. 242, 1932, except that the former organism affected adult birds and the latter was found only in baby chicks. Laboratory studies indicated that this was an instance of biological adaptation which could be changed at will.

The microorganism isolated in these epizootics is a haemoglobinophilic streptococcus and is responsible for a condition which has been called infectious bronchitis. The prevalence of this disease in the poultry population at large has not been determined. However, laboratory studies indicate that the mortality and loss in egg production may not be as serious as in infectious laryngotracheitis.

Avian Paralysis or Neurolymphomatosis. (C. S. Gibbs.) Pathological studies of avian paralysis have been continued through the year, and perivascular infiltration of round cells in the capillaries carrying blood and lymph to the nerves has been observed in incipient stages of the disease. Also metastatic infection of nerves from sarcomas in splanchnic tissue, by means of round cells conveyed in the blood and lymph vessels, has been evident in selected cases. A comparative pathological study of neurolymphomatosis and lymphatic leukemia has been undertaken. Up to the present it has not been possible to differentiate the hyperplastic tissues in lymphatic leukemia from certain forms of lymphoblastoma, although neurolymphomatosis may be readily differentiated from both on the basis of blood counts, differential blood stains, and gross pathology.

Cases of neurolymphomatosis from flocks in which the disease has been introduced comparatively recently show more inflammation and generalized lesions than those from flocks in which the disease has existed for a number of years.

WALTHAM FIELD STATION

(Waltham, Massachusetts)

Ray M. Koon in Charge

The research of this Station has been projected principally along the same lines as in 1931. As rapidly as conclusive results on any phase of a project have been obtained, they have been released to the commercial growers for application to their problems, without waiting until the completion of the entire project. For reports on experiments conducted at this Station, in addition to those listed under this caption, see reports of the Departments of Botany, Entomology, Floriculture, and Olericulture.

An increase of 50 per cent in the total number of visitors to the Field Station was recorded in 1932 over the year previous. During the year 2446 persons came to the Station for personal conferences with members of the staff regarding troubles threatening their commercial enterprises, or in quest of assistance with problems relating to amateur horticulture as it is practiced about the home. Telephone inquiries have numbered 2114; and 2748 letters (not circular) and over 2000 bulletins, leaflets, and mimeographs have gone out in answer to requests for information.

In March a two-day course offered to commercial flower producers and retail florists was attended by 225. A school for home gardeners, conducted for two days last April, was attended by 800 persons from 54 cities and towns in the eastern part of the State and several cities in Maine, New Hampshire, and Rhode Island.

The Boston Market Gardeners Association has continued to use the Field Station as headquarters for their monthly executive committee meetings.

The annual Field Day was held on August 3 with 888 farmers attending.

The Plant House. (P. W. Dempsey.) Interest in the plant house is increasing. Growers of both ornamental and vegetable plants are finding it of much value, and many amateur gardeners are also finding this type of structure economical to build and operate, and derive considerable pleasure from their winter garden. A new up-to-date plant house was built during the fall according to our latest plans, and an effort is being made to interest commercial concerns to standardize all the parts of the structure they sell.

Growers who have lost their source of heat (fresh manure) are now interested in installing hot water heating systems in their frames. The plant house offers such superior conditions for growing seedlings that the grower is advised to construct a plant house and use his frames to increase his capacity.

Electricity as a Source of Heat in the Hotbed and Propagating Bench. (P. W. Dempsey.) Work on this project was continued in both the greenhouse and hotbed. Interest on the part of growers is bound to increase as they become acquainted with this mild, controlled source of heat. Improvements in methods of use and type of equipment are constantly being made. Commercial growers in several states have installed rather extensive outfits.

From the results of this work it is recommended that growers go slowly in making an investment in installation and equipment, a trial bed or bench of from 4 to 10 sash being suggested. Operating costs at a current rate of 3 cents per kilowatt hour have been rather high. The cost of maintaining the temperature of a propagating bench (sand) 3 feet wide and 5 inches deep at 60° F. with the air temperature 50° F. was one cent for each running foot each 24 hours. Cost of the hotbed was $1.60 per sash for the season March 10 to May 20, with the minimum temperature 45° F. Hot water has proved as satisfactory and much lower in operating cost -- 50 cents per sash. Work will be continued to gain more essential knowledge of advantage to the grower.

Vegetable Variety Trials. (P. W. Dempsey.) Over fifty strains of sweet corn were planted on two different dates. The outstanding feature in this year's trials was the number of new strains of Early Golden Market, introduced some seven years ago by Gill Brothers of Portland, Oregon, appearing under different names -- Early Sensation, Yellow Sensation, Extra Early Yellow, Golden Hummer, Extra Early Golden, and others. These strains are certain to become popular since they all mature before Bantam and bear a large ear of Bantam quality. Golden Sunshine is but little different in general characteristics and is constantly gaining in popularity. In later-maturing varieties there is considerable interest in "Top-Crossed" and "Inbred" strains of sweet corn. The strains mature a heavy crop of excellent-quality ears of even size, and are of particular value for the cannery.

Forty-four strains and varieties of beets were seeded in two plantings. More attention is being paid to inside color of the root than formerly. Ohio Canner is a variety showing promise for a particular trade. It is rather small in size, of excellent quality, very dark in color, and matures evenly.

Eighty strains and varieties of tomatoes were planted, half of the plants of each strain being staked and half grown flat. The new variety, Pritchard, introduced by the United States Department of Agriculture, did not show up as well as ex-

pected. Seventy-five per cent of the staked plants of this variety were determinate, some producing only one cluster of fruit, and others ranging from two to four clusters. Grown flat, the growth was normal. Fruit was of good size and quality, but a large proportion showed an objectionable yellow under-color similar to that of Break O'Day. There is always much interest in our tomato trials on the part of all growers who visit the Field Station. Peculiar as it may seem, there is no variety which is outstanding year after year; therefore, it is difficult to make definite variety or strain recommendations to growers. Seasonal conditions affect the growth of tomatoes considerably.

Beans were included in the trials this year on account of the many new variety names found in the seed catalogues. There is a distinct trend in popularity toward the more extensive use of the round-podded varieties. Although the flat podded varieties Bountiful (green pod) and Sure Crop (wax) are still the most popular, there is more interest than ever in Pencil Pod Wax and the new round pod varieties Tendergreen and Stringless Black Valentine.

Twenty celery varieties made an exceptionally good growth in spite of the abnormally dry season. New variety names appearing this year in our trials were Golden Phenomenal, Golden Detroit, Utah Golden Crisp, Salt Lake, and Florida Queen. It will be necessary to try all of these again before final judgment is passed. Up to date, there is no reason for recommending that our growers make any change from the varieties they are now growing -- Pascal for winter and Golden Plume or Wonderful for summer and fall.

New names appearing on the variety lists of carrots also made it imperative to conduct a carrot variety test this year. Perfection, Pride of Denmark, and Imperator are very similar in type to the Coreless although much larger. All are uneven in size and type. Both favorable and unfavorable comments have been received from growers on all these varieties, so it is recommended that a grower determine just how each one performs under his conditions before planting any quantity. The new Red Cored Chantenay is certainly a big improvement in quality and the type is exceptionally uniform. Tendersweet, apparently a strain of Red Intermediate, is a carrot of exceptional quality and similar in color to the Red Cored Chantenay. Many local market gardeners are now using the Hutchinson variety for bunching, in place of the Chantenay and Danvers varieties formerly used for this purpose.

COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station. H. F. Bergman, Senior Pathologist, U.S.D.A., in Charge.

Development of Strains of Cranberry Resistant to False Blossom. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Reciprocal crosses between Early Blacks and McFarlins were made in July 1932. The crosses of Early Black by McFarlin were unsuccessful. The reciprocal cross of McFarlin by Early Black yielded a considerable number of fruits which matured normally. In order to determine the possible existence of resistant strains within single varieties, a number of flowers of the varieties Early Black, McFarlin, and Howes were self-pollinated. No fruits were obtained from selfed flowers of Early Black, but fruits were obtained from both the other varieties.

During September some fifty selections of wild cranberries were made in Maine. These selected wild vines were taken to East Wareham where they are being held over winter to be propagated in 1933. Several of the selected wild vines show very desirable vine and fruit characteristics.

Oxygen Content of Flooding Water in Relation to Injury to Cranberry Vines. (H. F. Bergman and W. E. Truran.) Some experiments to determine the effect of absence of oxygen in winter-flooding water on the development of terminal and fruiting buds during the following growing season failed because of unfavorable weather conditions. Several hundred buds of Early Blacks and Howes on the State Bog were tagged and their development was followed through the season. Large terminal buds tended to produce more fruits than either medium or small terminal buds. This tendency was more evident in Howes than in Early Blacks.

Regeneration of False Blossom Bogs. (H. F. Bergman and Jos. L. Kelley.) In cooperation with growers, two areas of bog badly infested with false blossom were sprayed in July with commercial weed killer (probably sodium arsenite) diluted 1:30 and applied at the rate of 600 to 800 gallons per acre. This treatment appears to be very satisfactory.

June Flooding for Fireworm Control. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Severe injury to flower buds and growing tips, due to low oxygen content in the flooding water, was observed in one bog during the flooding period for fireworm control. The lowest oxygen content found was 1.9 cc. per liter. Fireworms were apparently completely killed. No injury was observed on two other bogs. From experiments it appears that fireworms can be killed by submergence for 12 hours in water at a temperature of 15° to 20° C., and an oxygen content of less than 4 cc. per liter. An oxygen content of less than 1.0 cc. per liter for 5 to 6 hours causes injury to flower buds and growing tips.

June Flooding for Leafhopper Control. (H. F. Bergman and W. E. Truran.) Flooding for 16 to 18 hours killed about 75 per cent of the leafhoppers on one bog. The oxygen content of the water did not fall below 3.5 cc. per liter. No bud injury was observed. Flooding for 12 to 15 hours, on another bog, killed only about 50 per cent of the leafhoppers. The lowest oxygen values here were 3.5 to 4.0 cc. per liter.

Investigations on the Effect of Copper Residues from Bordeaux Spray on the Growth of Cranberry Vines. (H. F. Bergman and W. E. Truran.) The greatest amount of copper, which varies from 150 to 200 milligrams per kilogram of dry soil, is found in heavily sprayed bogs with a peat substratum. There is much less copper in soils of very wet bogs and of those with a sand substratum. The amount of copper in vines varies from 50 to 100 milligrams per kilogram of dry vines. The leaves ordinarily contain one and one-half to two times as much copper as the stems, for the same weight of material. In one experiment copper sulfate was applied directly to the soil in amounts equivalent to 800, 1200, 1600, and 2400 pounds per acre, without injury to the vines and with no apparent reduction in yield.

Spraying Experiments with Bordeaux and Organic Mercurial Sprays. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Spray plots were located on four separate bogs. Bordeaux made up by the 4-4-50 formula, with chemically hydrated lime, and applied at the rate of 350 to 400 gallons per acre was used on all bogs. Two organic mercurial sprays were used on one bog. The reduction

in the amount of rot showed a direct relation to the number of applications of the spray. The two mercurial sprays used gave as good control of fungous rots as the Bordeaux.

Storage Test of Cranberries. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Berries were stored in the basement of the State Bog building, at air temperature, which on November 1 was about 15° C., and later dropped to about 5° C. Cranberries from sprayed plots showed less loss from fungous rots than those from unsprayed plots. In the berries from two of the bogs this difference did not become apparent until about January.

COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in Cooperation with the Massachusetts Agricultural Experiment Station.

C. V. Kightlinger, U. S. D. A., in Charge

Black Root-Rot. (C. V. Kightlinger.) In continuation experiments numerous strains of Havana Seed tobacco were grown in the field during 1931 in a further attempt to find strains that will be satisfactory under Connecticut Valley conditions for resistance to black root-rot, type of plant, type and quality of leaf, and producing capacity. One strain was Havana Seed of the sort that is grown more commonly in the Connecticut Valley, known to be susceptible to black root-rot, but acceptable for type of plant and type and quality of leaf. This strain was used as a standard of comparison for types. One strain was Havana Seed 142A3, known to be satisfactorily resistant to black root-rot, and was used as a standard of comparison for resistance. Of the new strains being tested, eight had been grown in 1930, and seven were grown for the first time in 1931. These strains were all grown on land which in one case was free or nearly free of *Thielavia basicola*, and in another case was heavily infested with *Thielavia basicola*. Of the fifteen new strains tested in 1931 under these circumstances, eight were selected as apparently deserving further testing.

The production of these eight strains when grown on soil free or nearly free of *Thielavia basicola*, was as follows:

		Yields per Acre - lbs.	Grade Index	Crop Index
Havana Seed - Common strain		1868	.431	805.
Havana Seed 142A3		1828	.436	797.
Havana Seed - new strains	№ 5	2106	.474	998.
	№ 13	1946	.475	924.
	№ 14	1901	.482	916.
	№ 9	1897	.480	911.
	№ 22	1922	.460	884.
	№ 10	1807	.478	864.
	№ 23	1899	.445	845.
	№ 15	1818	.452	822.

The production of these same eight strains when grown on soil heavily infested with *Thielavia basicola*, with each strain having its own check of common Havana grown in adjacent rows, was as follows:

		Yields per Acre - lbs.	Grade Index	Crop Index
Havana Seed 142A3		2189	.470	1029.
Common Havana (check)		1237	.314	388.
Havana Seed - new strains	#5	2298	.470	1030.
	check	1315	.320	421.
	#13	2523	.459	1163.
	check	1415	.350	495.
	#14	2315	.430	995.
	check	1421	.340	483.
	#9	1925	.388	747.
	check	1285	.312	401.
	#22	1892	.341	645.
	check	1014	.277	281.
	#10	2023	.387	783.
	check	1364	.313	427.
	#23	2109	.411	867.
	check	1126	.290	327.
	#15	1895	.407	771.
	check	1410	.309	436.

Some of these newer strains deserve testing on a considerably larger scale in numerous places in the Connecticut Valley to determine their excellence in practical production.

Note: Grade Index is a number expressing the grading of all the tobacco produced by a strain in an experiment. It is based upon the percentage of grades, and the relative percentage values of these different grades, as given below:

Light wrappers	1.00	Long darks (19" & longer)	.30
Medium wrappers	.60	Dark stemming (17" & shorter)	.20
Long seconds (19" & longer)	.60	Fillers	.10
Short seconds (17" & shorter)	.30	Brokes	.10

Grade index is derived by multiplying the percentage yield of each grade by its respective price in the above schedule, adding the products, and dividing by 100.

Crop index is a number expressing crop value and is derived by multiplying the total acre production of tobacco in pounds by the grade index value of that particular tobacco.

Grade index and crop index and the adopted price relationships given above do not necessarily represent commercial values and prices.

PUBLICATIONS

Bulletins

280 Annual Report for the Fiscal Year Ending November 30, 1931. 64 pp. February, 1932.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

281 Experiments with Permanent Pastures. A. B. Beaumont. 36 pp. illus. April, 1932.

A large proportion of the farm land of Massachusetts consists of stony uplands more suitable for permanent pastures than for tilled crops. The improvement of pastures by top-dressing with fertilizers offers attractive possibilities; and the fact that large areas have already reverted to forest shows what must happen to existing pastures if fertilizer is not applied, or if the price of milk is too low to make such application profitable. A pasture which is weedy or run-down because of a lack of plant food can be brought back to productive condition only by the use of plant food. On the basis of the experiments reported, it is recommended that 1 ton of ground limestone (or its equivalent in hydrated lime) be applied every 6 years; 480 pounds of 16 per cent superphosphate and 160 pounds of muriate of potash, every 3 years; and 160 pounds of nitrate of soda, annually. At prices prevailing early in 1932, this treatment can be made by an annual investment of $5 to $10 an acre and it is believed will yield a fair return under Massachusetts conditions.

282 Relation Between Egg Quality and Price. Adrian H. Lindsey and Hubert W. Yount. 22 pp. May, 1932.

In order that the poultryman may feel justified in placing special emphasis on the quality of eggs and secure in making the extra expenditure involved in producing a higher grade product, he should have some assurance that quality values are recognized by the consumer. The most definite and significant relationship discovered from this analysis is that prices are directly related to weight under all conditions. That weight is a significant factor is not new, but it has not been known that weight is more important at one season of the year than another and that the premiums which are paid for weight are fairly definite. If premiums are known, it will be possible to determine by further research whether the production of large eggs is profitable.

283 Downy Mildew of Cucumbers. William L. Doran. 22 pp. May, 1932.

Downy mildew is a common and important disease of cucumbers in Massachusetts as well as in most of the eastern and southern states. The investigation included the source of primary infection, the effect of climatic factors, and the prevention of infection by the use of fungicides. All available evidence indicates that the fungus probably reaches Massachusetts from states farther south after a gradual northern movement by the aid of wind. Two to three hours on a leaf wet with rain or dew is enough for the germination of most of the conidia of this fungus, and five hours is sufficient to produce infection of leaves. In both field and greenhouse, copper fungicides are to be preferred to sulfur for the control of downy mildew. In Massachusetts the first application of a copper fungicide should be made, in the field, about July 25, and later applications should be made at weekly intervals. Bordeaux mixture 3:3:50 is a sufficient concentration for use in the field. Bordeaux 1:1:50 prevented infection of greenhouse cucumbers, and this is the concentration recommended for use in greenhouses.

284 Questions and Answers Concerning Pullorum Disease. H. Van Roekel. 23 pp. illus. May, 1932.

The purpose of this bulletin is to make available for the Massachusetts poultry industry information which will aid the poultrymen to improve their methods of establishing and maintaining pullorum disease-free flocks. The subjects covered are history and distribution of the disease, its nature and dissemination, control and eradication, including sanitary measures recommended.

285 The Relation of Temperature to the Activity and Control of the Plum Curculio in Apples. W. D. Whitcomb. 16 pp. illus. June, 1932.

The plum curculio frequently does more damage to apples in Massachusetts than all other insects together. As a result of the heavy loss to fruit growers, studies of the factors which influence the activity of this insect were conducted at Waltham. Early in the work temperature was found to play an important part in the problem of control, and the more recent studies have centered around this factor. Recommendations for Massachusetts, based on these studies, are: After the blossom petals have fallen, apply a special spray or dust in the first period of warm weather when the maximum temperature reaches 75° F. or higher and such temperatures promise to continue for 2 or more successive days. Use 4 or 5 pounds of lead arsenate in 100 gallons of spray, preferably with the addition of 1 pint of fish oil or linseed oil as a spreader or sticker. Except in severe infestations, 85-15 sulfur-lead arsenate dust can be substituted for the spray. When there are two distinct periods of high temperature within 15 days after the proper time for the calyx spray, apply a spray or dust in each period, using the same materials, and determining the time of application by the same temperature requirements as before. On scab susceptible varieties, or where the addition of a fungicide is desirable for any reason, liquid lime-sulfur or a similar material can

be added to the spray without danger of greatly decreasing the efficiency of the mixture for combating the plum curculio.

286 Types of Intensity in Rhode Island Reds. F. A. Hays and Ruby Sanborn. 11 pp. June, 1932.

Intensity or rate of laying is one of the very important inherited characters affecting annual egg production in poultry. Various methods have been used for measuring intensity, and there is an increasing need for more information concerning the relative merits of the different measures as well as for definite data concerning the relation of intensity to other traits affecting fecundity. Interrelations between the rate of laying in three different seasons and the relative values of six short-time measures of intensity are considered in this report. It was found that the most significant short-time measure of intensity is spring clutch size, but no short-time measure of intensity is as accurate as the mean clutch size for the entire year.

287 Frozen Fruits and Their Utilization in Frozen Dairy Products. M. J. Mack and C. R. Fellers. 28 pp. illus. July, 1932.

The frozen-pack method is used annually to preserve large quantities of fruit, much of which is later used for flavoring ice cream. Fruits used for this purpose have a very pronounced influence on the quality of the final product, but very little is known regarding the most satisfactory ways of processing fruit for utilization in frozen dairy products. The plan of the investigation was to prepare experimental packs of the fruits in one-gallon cans, freeze these under known conditions, store for approximately one year, thaw, examine carefully, and finally use the fruit in the manufacture of fruit ice creams, sherbets, and ices. The greater part of the study was with strawberries, but raspberries, peaches, cherries, and a few other varieties of minor importance were included.

288 The Relation of Feather Pigmentation to Intensity of Laying in Rhode Island Reds. F. A. Hays. 8 pp. October, 1932.

Deep rich plumage color and high winter laying intensity in Rhode Island Reds are desirable characters which can be influenced by breeding. This investigation was undertaken to determine to what extent both of these characters can be developed simultaneously by the breeder. It would seem to be a laborious process to establish uniform deep pigmentation and high intensity in a flock, but a medium shade of red should be maintained without difficulty.

289 Hereditary and Environmental Factors Affecting Variability in Egg Production. F. A. Hays. 12 pp. illus. December, 1932.

It is a well-known fact that both hereditary and environmental factors affect the number of eggs laid by a hen. Evidence is not conclusive on many points, however, and experimental data have not been reported to furnish information concerning the quantitative variation of specific fecundity traits from generation to generation. There is at present an outstanding need of a clear-cut distinction between the effects on fecundity of heritage and environment. Such a problem offers many difficulties, the most outstanding of which is the lack of any measure of fecundity in males. This report concerns itself with results obtained in carrying three lines of birds through four generations. Consideration is given to variability in five inherited fecundity characters: sexual maturity, intensity, winter pause duration, total days broody, and persistency. Variability in winter and annual egg records is also recorded. Such environmental influences as hatching date, increase or decrease in body weight, and daily house temperature are considered in relation to egg production and the relative importance of each is discussed.

290 The Story of Field A of the Massachusetts Agricultural Experiment Station: A Review of Experiments with Nitrogen Fertilizers. Fred W. Morse. 23 pp. illus. November, 1932.

The year 1932 marks the fiftieth anniversary of the formal organization of agricultural research at Massachusetts State College. It was in November, 1882, that the Experiment Station was established, and field plot experiments begun the next year represent some of the first activities. It seems fitting, therefore, after this fifty-year period, that results from this work be compiled and recorded in permanent form. Field A was laid out in 1883 on "run out" hay land and included eleven plots of one-tenth acre each. Seven successive crops of corn were grown from 1883 to 1889, to study the effects of different forms and kinds of plant food. The earlier harvests showed potash to be the most needed fertilizer; the later ones indicated that a complete fertilizer had become necessary. Four standard types of nitrogen fertilizers -- nitrate of soda, sulfate of ammonia, dried blood or fish or cyanamid, and stable manure -- were compared in 1889, and the comparison was continued with minor

changes until 1921. A variety of crops was grown, and tables show results obtained with oats, soy beans, potatoes, hay, corn, and miscellaneous crops. The value of Field A to agriculture is its history of the diversity of results. Back of any subsequent work upon it are authentic records of each plot, of which no similar records were to be had when the field was laid out.

291 Two Systems of Feeding Dairy Cows: High Roughage and Low Grain versus Low Roughage and High Grain. J. B. Lindsey and J. G. Archibald. 15 pp. December, 1932.

The amount of grain to be fed to cows is a question of perennial interest to farmers, particularly in a state like Massachusetts where grain is bought outright, while roughage is grown at home. Though much has been written on the subject, it has been largely opinion unsupported by experimental evidence. This bulletin reports the results of a long-time experiment (October 1, 1928 to March 31, 1932) conducted at this station. Viewing the results as a whole, the low roughage group of cows had a rather better record. They looked thriftier, put on more flesh, milked more freely, maintained their production better from year to year, maintained their average test better, and were more nearly mormal in their reproductive function. It was evident that cows will not produce to the limit of their ability on a high roughage system of feeding. Which method of feeding will produce milk more economically, however, depends very largely on local conditions as to production and markets, and in a large measure is a problem to be solved by the individual farmer.

292 Carbon Disulfide Emulsion for the Control of the Root-Knot Nematode. E. F. Guba. 16 pp. illus. December, 1932.

Many greenhouse establishments lack the necessary means for sterilizing soil with steam or hot water. Even where these methods are practiced with successful results, they are laborious and slow and require expensive equipment. Experiments have been conducted which show that the use of carbon disulfide emulsion as a soil drench in greenhouses can be relied upon to greatly reduce the root-knot nematode as a factor causing crop loss, at a cost of approximately $0.009 per square foot for chemicals. Carbon disulfide emulsion is compatible with formaldehyde. A stock emulsion containing 68 per cent carbon disulfide, 26 per cent water, and 6 per cent rosin-fish-oil soap in a 1:50 concentration for controlling the root-knot nematode, with the addition of 2/3 gallon of formaldehyde if soil-inhabiting fungi are a factor, is effective. The addition of formaldehyde adds about $0.007 per square foot to the cost of the treatment.

Control Bulletins

62 Seed Inspection. F. A. McLaughlin and Margaret E. Nagle. 47 pp. February, 1932.

63 Twelfth Annual Report on Eradication of Pullorum Disease in Massachusetts. H. Van Roekel, K. L. Bullis, O. S. Flint and Miriam K. Clarke. 80 pp. September, 1932.

64 Inspection of Commercial Feedstuffs. Philip H. Smith. 48 pp. September, 1932.

65 Inspection of Commercial Fertilizers. H. D. Haskins. 50 pp. October, 1932.

66 Inspection of Agricultural Lime Products. H. D. Haskins. 8 pp. December, 1932.

Meteorological Reports

517 - 528, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. C. I. Gunness. 4 pp. each.

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121 Putting First Things First in Agronomy. F. J. Sievers. Jour. Amer. Soc. Agron. 24:29-32. January, 1932.

122 The Effect of Environment on the Nematode of the Tomato Gall. Linus H. Jones. Jour. Agr. Research 44:275-285. February 1, 1932.

125 An Ataxia of Chicks Associated with Nephritis. Glen L. Dunlap. Jour. Amer. Vet. Med. Assoc. 80 (N. S. 33): 880-885. June, 1932.

126 Acetic Acid and Pyroligneous Acid as Soil Disinfectants. William L. Doran. Jour. Agr. Research 44:571-578. April 1, 1932.

127 Stomatal Apparatus of the Cultivated Cranberry, *Vaccinium Macrocarpon*. Wm. H. Sawyer, Jr. Amer. Jour. Bot. 19:508-513. June, 1932.

128 A New Jelly-Strength Tester. C. R. Fellers and J. A. Clague. Indus. and Engin. Chem., Analyt. Ed. 4:106. January 15, 1932.

129 The Significance of Differences in Means in Repetition Experiments. F. A. Hays. Poul. Sci. 11:14-17. January, 1932.

130 A Three-Year Study of the Chemical Composition of Grass from Plots Fertilized and Grazed Intensively. J. G. Archibald, P. R. Nelson and E. Bennett. Jour. Agr. Research 45:627-640. November 15, 1932.

131 Susceptibility of Chickens to Brucelliasis. H. Van Roekel and others. Jour. Amer. Vet. Med. Assoc. 80 (N. S. 33): 641-642. April, 1932.

132 The Mineral Composition of Dates. M. M. Cleveland and C. R. Fellers. Indus. and Engin. Chem., Analyt. Ed. 4:267. July 15, 1932.

133 Rapid Centrifugal Method for Pectic Acid Determination. C. R. Fellers and C. C. Rice. Indus. and Engin. Chem., Analyt. Ed. 4:268. July 15, 1932.

134 The Influence of Temperature on the Nitrate Content of Soil in the Presence of Decomposing Cellulose. James E. Fuller and Linus H. Jones. Soil Sci. 34:337-350. November, 1932.

135 Early and Late Feathering in Rhode Island Reds. F. A. Hays. Amer. Nat. 66:286-287. May-June, 1932.

136 Public Health Aspects of Frozen Foods. Carl R. Fellers. Amer. Jour. Pub. Health 22:601-611. June, 1932.

137 Monograph of the Genus Pestalotia, Part II. E. F. Guba. Mycologia 24: 355-397. July-August, 1932.

139 Chronic Carriers of Infectious Laryngotracheitis. Charles S. Gibbs. Jour. Amer. Vet. Med. Assoc. 81: (N. S. 34): 651-654. November, 1932.

144 Vitamin C in Canned Citrus Products. Carl R. Fellers and Paul D. Isham. Jour. Home Econ. 24:827-832. September, 1932.

146 Recent Developments in Ice Cream Manufacture. M. J. Mack. Food Industries. August, 1932.

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